Robert L. Zimdahl

AGRICULTURE'S Ethical Horizon

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The question of questions for mankind—the
problem which underlies all others, and is more
deeply interesting than any other—is the
ascertainment of the place which Man occupies
in nature and of his relations to the universe of things.

Thomas H. Huxley
Man's Place in Nature, 1863

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Foreword

Paul B. Thompson
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In one sense, the current era of agricultural ethics began in the 1970s when Glenn L Johnson, an agricultural economist known for his work on asset fixity, took a sabbatical at Oxford University to work with several philosophers there. The result was a series of papers calling for a new area of explicit and logically critical exposition of the values underlying applied and problem-solving research in the agricultural sciences (1976, 1982). One could also argue that there has been a continuous and unbroken string of ethical and philosophical reflections on agriculture that can be dated back at least to Xeonophon's *Oeconomicus* in the fourth century BC. Here, one would trace a succession in the twentieth century that notes the writings of Liberty Hyde Bailey, Louis Bromfield, and Wendell Berry. Bailey (1858–1954), best known as a taxonomist and for his leadership as the Dean of Agriculture at Cornell University, was almost certainly the leading agricultural scientist of his generation. In addition to his many scientific publications, he contributed a number of reflective philosophical essays, including *The Holy Earth* and his work for the Theodore Roosevelt administration's Commission on Country Life.

Louis Bromfield (1896–1956) was a novelist and Hollywood screenwriter who turned his pen to farming after returning to his Ohio homeland in the 1940s. During the 1950s he became a potent spokesman for conservation and the values of rural life, but his writings are little appreciated today. Wendell Berry (born 1934) is the current generation's Bromfield. The Kentucky poet and novelist has perhaps become best known for his writings on farming and conservation. But Bailey was a leading agricultural scientist in his own right, and Bromfield worked closely with agricultural scientists such as Hugh Hammond Bennett (1881–1960), the father of soil conservation in the United States. Berry, in contrast, largely has been ostracized from the agricultural science establishment. His trenchant critique of land-grant university science and education in the 1977 book *The Unsettling of America* caused him to be perceived as an enemy by those agricultural scientists who were aware of him. For reasons that Robert Zimdahl makes clear

in this volume, most faculty at agricultural universities in the 1970s and 1980s simply ignored Berry.

The transition from Bailey to Berry is thus significant, and the neglect that post-war agricultural science showed for ethics was both a central point of analysis not only for Johnson's essays of the 1970s, but also for this extended and systematic study by Zimdahl. Johnson and Zimdahl both emphasize the rise of positivism as a philosophy of science within agricultural universities and research organizations. Positivism can be succinctly defined as the view that agricultural scientists should confine their activity to the collection of empirical data and to the analysis of quantifiable relationships among data. It is, on the one hand, clear that agricultural scientists have never so confined themselves. If Norman Borlaug is the prototypical agricultural scientist of the late twentieth century, one must note his tireless work to ensure that modern maize, rice, and wheat varieties responsive to fertilizer would be supported by government and accepted by farmers, not to mention his public advocacy on behalf of the green revolution (see Borlaug, 2000). On the other hand, it is undeniable that sustained, critical debate over the goals of agricultural science has been exceedingly rare during Borlaug's professional lifetime. Positivism is the philosophy that holds that such debate has no place in science. To the extent that scientists such as Borlaug campaign on behalf of their preferred vision of agriculture, it is considered to be an extra-scientific activity, a necessary evil, perhaps, but in no sense part and parcel of the scientific process itself.

As I have argued elsewhere (Thompson, 2004), this brand of positivism had its philosophical roots in a short-lived philosophical movement associated with the Vienna Circle philosophers Morritz Schlick (1882–1936), Rudolph Carnap (1891–1970) and Kurt Gödel (1906–1978), among others. The Vienna Circle philosophers were active in the 1920s and early 1930s, but this philosophical movement may have had its greatest influence over post World War II through a single book, A. J. Ayer's *Language, Truth and Logic*, published in 1936. The key philosophical doctrine rests on a theory of meaning that had been promulgated by Gottlob Frege (1848–1925), according to which the "sense" of a word or sentence must be distinguished from the thing or state of affairs to which it refers. As Ayer (1910–1989) expressed it, statements are meaningful only if one of two conditions hold: they express purely conceptual relationships that arise in virtue of definitions (the mental "sense") given to terms, or they correspond to (that is, describe) possible states of the world. Ayer proposed a "verification principle" for determining whether sentences met the second, empirical criterion for meaning, to wit, that all empirically meaningful sentences, in principle, are capable of being determined true or false through the collection and analysis of data. One consequence of this view was that sentences expressing norms or values were deemed neither true nor false, but "meaningless." The positivists denigrated such talk, labeling it as "metaphysics," and implying that it was tantamount to the outdated superstition of a bygone era.

This form of positivism has had a profound impact on the history of science since World War II. It has vindicated countless decisions by journal editors, tenure, promotion, and review committees, not to mention individual scientists, who rejected and repressed themselves or their colleagues when they engaged in speculative, philosophical, and reflective exercises on the grounds that such activities are "not science." In fact, the Vienna Circle philosophers who survived the war and enjoyed distinguished careers in the United States had discovered a host of problems in the verification principle by 1950. Each had significantly modified their views, adopting a form of pragmatism that recognizes the value-laden character of knowledge, as did Ayer himself. Nevertheless, *Language, Truth and Logic* was assigned widely in classrooms well into the 1980s, and undoubtedly had a profound influence on the philosophical views of scientists who were educated in the fifty-year period following its original publication in the 1930s.

The other book of philosophy that was especially influential was Karl Popper's *Logic of Scientific Discovery*, published in 1935 and translated into English in 1959. Here, Popper puts forth the view that science progresses not through verification, but through falsification, by eliminating hypotheses that are inconsistent with data collected through experiments. Popper's characterization of scientific logic also yielded the view that science properly is occupied with the formulation of hypotheses that predict specific outcomes. Although such hypotheses are not "proven" when the predicted outcomes materialize, the failure of a prediction falsifies the hypothesis in question. Crucially, hypotheses incapable of such falsifying tests cannot be characterized as properly scientific on Popper's view. Although the view that science properly is concerned with the collection of data and the analysis of relations among data rests jointly on the positivist rejection of metaphysics and on Popper's more sophisticated characterization of progress through falsification, Popper was one of the most severe critics of the verification principle from the very outset. In part, his criticism focused on his view that proving false was more important than proving true, but he also believed that one would never be able to actually conduct falsifying experiments without also engaging in philosophical arguments intended to frame and contextualize empirical research, including debates over *which* experiments to conduct and *how* to conduct them. There is a world of difference between Popper's belief that ethical norms cannot be subjected to logically decisive falsifying tests and the belief that they are wholly meaningless.

Popper was right. Science cannot be done without philosophy, and this philosophy includes ethics. In fact, the statement that scientists should confine themselves to the collection and analysis of data *is* an ethical norm, a norm for the conduct of inquiry. Such norms cannot become widely established in scientific practice without a significant amount of philosophical discussion and argument. Thus, in addition to the value-laden campaigning for which Norman Borlaug is so well known, there have been countless conversations and exchanges in which

scientists have established the positivist tenet as an ethical principle for inquiry in the agricultural sciences. In fact, the journal editors and tenure committees who have imposed this norm of practice have not succeeded in eliminating metaphysics, ethics, and philosophy from scientific disciplines. They have succeeded only in expunging such philosophical reflection from the scientific record. The result is that a significant amount of the work that was necessary to make science possible in the last half of the twentieth century cannot be passed down to the present generation, nor can it be brought before a public anxious to believe that science is conducted according to a discipline of logic, honesty, and adherence to standards of rigor.

The actual philosophy of scientific practice for the period in which the agricultural disciplines took their present shape is thus as ephemeral as the casual remarks that the scientists who built these disciplines exchanged over coffee. Where are the books and articles in which the scientists of the 1950s and 1960s articulated the rationale for developing chemical pesticides, herbicides, and fertilizers? Where are the course syllabi in which instructors in the agricultural sciences discussed alternative approaches for understanding agriculture's impact on the broader environment? Where is the evidence that this generation of scientists debated and perhaps rejected the ideas of Albert Howard? The failure to record the considerations and deliberations that led scientists to undertake the studies that led to the rise of chemical and molecular technologies in the plant sciences, and to a mechanical revolution in animal husbandry, has left the current generation vulnerable to the charge that such developments were undertaken in secret by profit- and power-seeking individuals with little regard for farmers, farm animals, the environment, or the broader public.

Even under assault from authors such as Rachel Carson or Wendell Berry, the agricultural disciplines of the 1960s, 1970s and 1980s displayed too little willingness to articulate the reasons for, values behind, and logic of their science. I have argued that an implicit and poorly articulated utilitarianism was integrated into the rationale for agricultural science. According to this view, the rising productivity of industrial agriculture leads to lower food costs for consumers (Thompson, 1995). The argument runs like this: Because food is essential, because everyone eats, and because expenditures for food are particularly critical for the poor, the net benefit from lower consumer prices for food offsets any cost experienced in the form of environmental impact, as well as farm bankruptcies and associated impacts on rural communities that may occur as farms become larger and fewer. Although a few agricultural economists, notably Luther Tweeten (1984), have accepted the importance of articulating the utilitarian rationale of this argument explicitly, this view—if indeed it *is* the view of mainstream agricultural scientists—remains wholly implicit within the biologically oriented agricultural sciences. Does the current generation of scientists see no reason to articulate the rationale for doing what they do, to engage in self-reflection, or for defending what they do against mounting criticism?

Thankfully, the answer is, "Not entirely." The movement to embrace ethics has gone farthest and most quickly in the animal sciences, beginning not surprisingly with entomology. The controversy sparked by Carson's *Silent Spring* in 1962 did indeed result in substantive debate within this discipline. Robert Van Den Bosch offered a book-length ethical critique of his discipline in 1978, and entomologists were among the first faculty in agricultural science to publish in the journal *Agriculture and Human Values* shortly after it was launched in 1982. However, it is fair to note that this self-criticism within the discipline of entomology did not embrace the vocabulary and conceptual resources available within philosophical ethics and the philosophy of science. Livestock researchers, the last group of agricultural scientists I would have expected to break with positivism when I began my own work on agricultural ethics in 1980, were in fact the first to do so. In retrospect, it is not surprising that this group would move first because no other area of the agricultural sciences has been subjected to such sustained criticism from so many different directions. The lead issue, of course, has been the welfare of livestock in concentrated animal feeding operations, but the food animal industries have dealt with enormous issues with respect to environment, food safety, and changes within farm structure, as well (see Thompson, 2001). Here the charge has been led, perhaps, by my philosophical colleague, Bernard Rollin (1995), who had at least a ten-year head start on me in his work on ethical issues in agriculture. But many animal scientists have taken up the task of articulating, critiquing, and refining the key norms for their discipline. Here, one must note papers by David Fraser (1997, 1999) and Keith Schillo (1998, 1999), along with Ray Strickland's efforts to establish a standing bioethics section at the annual scientific meetings. Here also there are at least two book-length studies on ethical issues by animal scientists: Peter Cheeke's *Contemporary Issues in Animal Agriculture* (1998) and H. O. Kunkel's *Human Issues in Animal Agriculture* (2000).

Things are not as well developed on the plant side. There is, of course, Wes Jackson, but Wes long ago forsook the agricultural university/experiment station complex to become friends with Wendell Berry, and no one would take his ideas to represent reflective self-criticism on the part of mainstream crop production science. From the mainstream, the first hints of a call for ethics only now are being heard. Writing for the centennial issue of *The Journal of Agricultural Science*, L. T. Evans closes his reflections on the last 100 years by noting that "future agricultural scientists will be called on not merely to enhance agricultural production, but also to consider more explicitly the ethical as well as the environmental consequences of their research" (2005, p. 10). Maarten Chrispeels (2003) has coauthored an article entitled "Agricultural Ethics," and included a series on the topic as editor of *Plant Physiology*. But so far as I know, the volume that you hold in your hands is the first book-length study to incorporate sustained ethical and philosophical reflections by a mainstream agricultural scientist working with plants or crop production, at least since roughly the time that Liberty Hyde Bailey

published *The Holy Earth*, in 1915. Zimdahl has also gone farther into the philosophical literature than any of the scientifically trained authors listed earlier. The book you are reading now contains sophisticated expositions of philosophical concepts such as utilitarianism and positivism, and develops a careful application of these concepts to the practice of agricultural science.

Some will read Zimdahl's analysis and react in anger. In itself, that is fine. There are certainly different philosophical positions that can be taken with respect to the philosophy of the agricultural sciences than the one Zimdahl develops in the following pages. What must happen next, however, is the translation of that reaction into words, then into arguments intended to show just where Zimdahl goes wrong in the reader's mind. These debates need to be aired at scientific meetings, and the reactions to this book need to find their way into print, if not in the major scientific journals then in outlets such as *Agriculture and Human Values* or *The Journal of Agricultural and Environmental Ethics*. Finally, there must be significant portions of graduate education in the agricultural sciences given over to the philosophy of agricultural science. Only then and by such means will the public record of values and rationale for agricultural research be constructed and laid open to anyone who cares to look. What is more likely is just what Zimdahl anticipates. Those who disagree with his book will ignore it, just as they ignored Wendell Berry. Perhaps this will arise from the mistaken and ultimately self-serving belief that to cite and discuss literature that one disagrees with is to lend credibility to its conclusions; or perhaps it just *is* the continuing legacy of positivism that prevents scientists from engaging in the debate that so desperately needs to happen.

Even the brief and idiosyncratic list of works listed in this preface shows that agriculture was not wholly without any philosophical reflection during the last half of the twentieth century. The trouble is that this reflection was disjointed, each effort emerging *de novo* as if nothing had gone before. Here, too, Zimdahl's approach is an important departure from the norm. My challenge to the reader of Zimdahl's book, then, is to respond in kind. Even for those who are largely sympathetic with the main thrust of Zimdahl's argument, there is a responsibility to offer him the benefit of engaged criticism. It is only through the give and take that occurs when philosophical ideas are batted about that a literature in the philosophy of agricultural science can be built. It is only by authors being willing to articulate the reasons why they see things one way rather than another that we can have a public record of the values that underlie research and technology choices in agriculture. It is only through such a public record that we can have the ability to sharpen, refine, and reevaluate those choices from one generation to the next. And perhaps even more importantly, it is only through such a public record that we can have any confidence that something more than the most self-seeking and venal motives actually are guiding the key decisions that are made when articles are published or rejected, scientists are tenured or denied, grants are awarded, and technology is developed.

It is not in its emphasis on data, logic, rigor, or even quantification that positivist philosophy of science fails. All these values, perhaps better articulated by Popper than by Ayer, should be cherished. The error came in establishing a practice of silence among agricultural scientists when it comes to articulating, critiquing, and then defending various reasons and rationales for doing things one way rather than another. This practice is irresponsible because it fails future generations of scientists, who are deprived of the ability to survey those rationales, examining their strengths and possibly also finding places where they need to be adapted to changing circumstances. Silence is especially irresponsible within the land grant mission of public science, where the public has a reasonable expectation that research choices be consistent with a broad conception of the public interest. Because the public interest itself is an open-ended, evolving, and revisable ideal, it is doubly critical that science intended to serve the public interest be engaged in an ongoing and public process of evaluation and debate. Zimdahl has taken giant steps in the direction of restoring a practice nobly evident in the legacy of Liberty Hyde Bailey. Let us hope that his colleagues will not fail to honor both Zimdahl and Bailey with a considered response.

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Preface

> *My conduct this day, I expect, will give the finishing blow to my once great and now too diminished popularity. . . . But thinking as I do on the subject of debate, silence would be guilt.*
>
> John Dickinson of Pennsylvania speaking against independence on July 1, 1776 during the Continental Congress in Philadelphia.

This book is the result of the development of a career in agriculture. It is neither a Homeric story of great, heroic deeds nor a story that will change civilization or be told over and over again. It is a small story of the life of one mind that began in one agricultural sub-discipline, weed science, and ended elsewhere.

After completing a Master of Science degree at Cornell University in 1966 and a doctorate at Oregon State University in 1968, I arrived in Fort Collins, Colorado to begin a new life as an Assistant Professor of Botany and Plant Pathology at Colorado State University. The job required teaching a class—the Biology and Control of Weeds, and doing research on soil persistence of herbicides and weed control in agronomic crops. It was the long desired opportunity and I knew I was ready to take full advantage of it.

In the beginning of my university career, life and work resembled a mobile my wife gave me some years ago.[1] It hangs in my home study and consists of a black paper circle and three porpoises made from red construction paper; each with a sharply contrasting black eye. Each porpoise hangs from a string at the end of a slim metal wire and they move alone or in unison, with frail elegance, grace, and beauty. I walked into my study one morning expecting to admire the porpoise's elegant, floating grace and they were gone. The supporting stick,

[1] I am indebted to Dr. D. A. Crosby, Professor Emeritus of Philosophy, Colorado State University for this metaphor.

fastened so carefully, had come loose and the mobile had fallen to the floor. The frail elegance was no more. As I reflect on my weed science career, its direction, and on what I thought and knew as fact when I began, I know my career has resembled my mobile.

In 1968, and for some years after, my life was fascinating and everything moved forward in order and harmony. I knew the Vietnam TET offensive occurred on January 30, Martin Luther King was assassinated on April 4, Robert F. Kennedy was assassinated on June 5, and Neil Armstrong and Buzz Aldrin walked on the moon on July 20 but these distant events, while very important, didn't affect me, my family, or my new career. Then the stories and facts about the use of the herbicide 2,4,5-T during the Vietnam war intervened. My career's supports began to loosen. I began to doubt if what I knew to be the foundational facts and the supporting myths of my science were adequate. It was, in a very real way, a crisis of faith; a crisis of faith in science.

In 1964, a study initiated by the National Cancer Institute suggested concern about the public safety of 2,4,5-T, an important herbicide for woody rangeland brush control and for forest weed control. By 1950, 4.5 million kilograms (9.9 million pounds) of 2,4-D and 2,4,5-T were being applied annually in the United States (Wildavsky, 1995, p. 82). The National Cancer Institute study indicated the possibility that 2,4,5-T or one of its formulation's constituents might be a teratogen. Other allegations appeared over the next several years, many because an ester form of 2,4,5-T was half of Agent Orange, a defoliant used in Vietnam. By 1970 there was enough toxicological evidence to halt military use of 2,4,5-T and for the U.S./Environmental Protection Agency (EPA) to initiate administrative proceedings to suspend its registration. Throughout the 1970s increasing attention was given to the dioxin contaminant in 2,4,5-T. Extensive studies confirmed that a dioxin[2] was the teratogen in 2,4,5-T. In 1979, following a still controversial study of human miscarriages after 2,4,5-T had been used in forests in the Alsea basin of Oregon, the EPA issued an emergency suspension of all uses of 2,4,5-T for forestry, rights-of-way, and pastures. Public sentiment against the herbicide grew in the 1970s. The manufacturers and EPA attempted to negotiate settlements to keep some uses but discussions broke down in 1983 and all U.S. uses were canceled by the EPA in 1985.

In 1971, I presented a volunteer paper titled, Human Experiments in Teratogenicity, in the ecology section of the Weed Science Society of America meeting in Dallas, Texas. The philosophical supports of my elegant, ordered, satisfying professional life began to crumble after that paper. The major objective of the paper was to question the role weed scientists played and ought to play in an increasingly polluted world. I was troubled and asked my colleagues to help me think about under what conditions it is possible to say that a pesticide is so necessary

[2] There are several dioxins. The dominant teratogenic molecule that was in 2,4,5-T was 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD).

to our food production system that any risk of human harm is acceptable. The paper suggested pesticides were means to the desirable end of food production. I proposed that those who work with pesticides must ask and answer questions about whether means and ends are compatible. The paper argued that members of society must feel they are participants in determining the way things are ordered. They must think they have and actually have the power to choose. To make the sense of choosing and participation real, people must have the evidence required to judge possible alternatives. People must also have, beyond the evidence, a sense of general purpose that serves as a context into which particular judgments are fitted.

The room was partially full for my paper. The normally perfunctory applause was minimal. A group of colleagues spoke to me after the paper to tell me how wrong I was. The essence of the rather unpleasant encounter was that they wanted to know why I was so eager to bite the hand that fed me and much of the rest of the world. Their comments assured me that something was wrong but it was something that was wrong with me and my thinking. In my colleagues' view, there was nothing wrong with agriculture, weed science, or with herbicides. They believed that weed scientists should continue the scientifically responsible quest for wise use of federally approved herbicides. I knew something was wrong but wasn't able to define it well, and I was beginning to doubt that the unquestioned development of herbicides for agriculture was *a priori* good.

A 1972 paper (Zimdahl, 1972) elaborated the oral presentation and continued the quest to decide what I thought and see if anyone cared. The issues didn't go away. I continued to read and think and tried to learn more about the issues when I wasn't doing the teaching and research my job required. A second paper (Zimdahl, 1978) was published later in the same journal. It included two fundamental propositions.

1. Some species are pests and it is necessary to control their populations to produce food.
2. Pesticides are the primary means to control pests but there may be an unnecessary dependence on them.

The paper argued that special knowledge and the highly trained mind produce their own limitations. They tend to breed an inability to accept views from outside the discipline usually owing to a deep preoccupation with the discipline's conclusions.

After doing weed science research and teaching for 20 years and making another attempt to clarify my thoughts (Zimdahl, 1991), it was time to reflect on what had been learned and plan my future. This led to work on the values and ethics of agriculture and particularly of weed science. This required learning how to do things I didn't know how to do; an old dog that wanted to learn new things. Exploring the ethical foundation of a science that had been my professional life was what I wanted to do.

Such decisions and changes, especially radical changes, don't come without costs. The costs have been personal and financial. It had taken a long time to realize that solving weed problems was a very important task but not the one I wanted to spend the rest of my career working on. The personal cost has included loss of colleagues and friends who don't understand and assume the worst. In the minds of many, I am biting the hand that feeds me. The costs also include the financial and intellectual difficulty of venturing into philosophy—a new, unknown area. The financial cost was just that; ethical reflection does not provide opportunities for research grants offered by the study of the kinetics of herbicide degradation in soil. Learning how to reflect on the history and values of agriculture and weed science has been a difficult challenge.

Freeman Dyson (1988) reflected on physics, his discipline, and said it was "passing through a phase of exuberant freedom, a phase of passionate prodigality." Weed scientists have always been exuberant and prodigious in their scope of work and ambition for the future. During weed science meetings, others, most especially the young, revel in their exuberant freedom. They walk confidently along trails that, to me, are almost invisible, discussing ideas I don't even have the vocabulary to discuss. They are not wandering aimlessly. They are explorers, mapping the territory, finding the way to a new weed science with new scientific terminology and, perhaps, a new territory. However, this book suggests that these capable explorers lack an understanding of the ethical foundation of agriculture and of weed science. Indeed they often lack a concern for discovering the ethical foundation of their work.

I often feel like a foreigner at weed science meetings even though I share a language with my colleagues. As I overhear conversations or listen to papers, I often feel as I have felt when lost in a foreign city. I don't know the language and can't find the way home. When wandering the streets in a foreign city, I often don't know the best route to my destination. I frequently can't understand the signs or the spoken words. I don't know the language. There are people all around, speaking, laughing, eating, trading ideas—the stuff of life. There is an intricate profusion of activity, and, as I walk, the surrounding activity seems to grow in complexity and abundance and my confusion, my sense of direction worsens, at the same, or at a faster, pace. The natives are, of course, at home. They understand and only I am confused.

I am puzzled by the new directions of agricultural science and seek direction and confidence as I explore the ways of ethics, a route I have learned, but one my colleagues have not trod. Predictions about the future of agricultural science by scientists, say that it is good, essential, and going to get better. When I was a student I don't recall hearing the word sustainable, and the environment was acknowledged but not endangered. Weeds were invaders of crops but they were not invasive species, a new and growing area of study. Genetic engineering of species was unknown. All of these are now powerful ideas with powerful constituencies and they are changing agriculture's direction and its foundational ideas.

Hopes will be dashed, new elites and new ideas will consolidate power and privilege and frustrate the dreams of others. Dreams of more equitable and just societies may be at risk. It is wise to remember, as we change, that agriculture and the technology of its sub-disciplines can affect and be affected by the development, direction, and future of the greater society.

The central norm, the primary moral stance of agronomy, plant pathology, weed science, entomology, indeed of agricultural science is that the scientific research that is done should benefit humanity by aiding the production of food and fiber. Agriculture and its technological disciplines are primary moving forces behind many social changes. Agriculture is one of the few production activities that takes pride in and seeks public adulation for reducing its labor force and weed science has been a major contributor. What becomes of the people displaced is someone else's problem.

My quest, what I have learned in a new language, albeit slowly, is to think about and then try to engage students and my colleagues in thought about what constitutes an appropriate ethical basis for making judgments about value differences in agriculture. I have learned that among my agricultural colleagues, "concern about moral questions is often relegated to the realm of private anxiety, as if it would be awkward or embarrassing to make it public (Bellah et al. 1985, p. vi). I have also learned that we must take the risk of appearing awkward and being embarrassed as we discuss: What are the goals of agricultural science? What should the goals of agricultural science be? What should the goals of weed science be? How do and how should the practitioners of agriculture address complex ethical questions?

The aim of my ethical quest and the goal of the learning process is not what many have assumed. Many think what I want to tell them is that they are ethically wrong because they have no ethical foundation for their work. They are wrong. It is not a matter of sorting things out to a final, definitive truth that I understand and others do not. The aim is to construct a more harmonious and mutually acceptable view from which to address existing and future value conflicts. The aim is not unanimity, but a functional, mutually respectful plurality; not a solo, a practicing chorus. And, as is true for all good choruses, the practice must continue. Discussion of foundational values, of why we practice agriculture as we do should become a central rather than peripheral or absent part of agricultural practice and education.

One of the important things I have learned is that the persistence of moral conflict, of value questions, is an inevitable and important part of the human condition. Engaging in the ensuing debate stimulates the full development of the intellect and of humanity. Such discussions normally occur in a time of political and cultural imponderables. Calm discussion and rational thought may be impeded by irrational anger. Dyson (1988) said that calm discussion is akin to holding a small candle in a hurricane to see if there are any paths ahead where people who share goals can walk together, while thinking about and planning

their future. A fear and perhaps a fact is that if agricultural scientists do not venture forth to understand and shape the ethical base of the future, it will just happen or it may be imposed by others.

The primary purpose of this book is to continue the discussion of agricultural ethics begun by others (Aiken, 1984; Blatz, 1991; Lehman, 1995; Mepham, 1998; Thompson, 1995, 1998; Thompson et al. 1994) each of whom will be cited as we proceed. Of current interest is the 2004 manuscript compilation produced from a series of articles that appeared in *Plant Physiology* from 2001 to 2003 (Anonymous, 2004). The goal of this book is to explore agriculture's ethical horizon; the boundary line that separates and delineates one's outlook and knowledge. There will be special focus on weed science. The perpetuation and improvement of agriculture and weed science is my goal.

> Never will it teach us all we need to know. Never will it provide us with final answers, and since none exist, then science's weakness becomes science's strength. Never will it cease its controversies, and that too is just as well if truth, like infinity, is to be eternally sought, though never captured. So it is that I must prefer the informed to the convinced, the demonstrated to the revealed, the observed to the imagined, the probable to the impossible, the unalterable fact to the evanescent wish, the reasoned conclusion—however offensive—to the unquestioned assumption—however pleasing.
>
> Ardrey, R., 1976
> The Hunting Hypothesis. p. 71

Ardrey's is a plea for reasoned conclusions. It is reason—the ability to think, form judgments, draw conclusions coherently and logically—that guides one in the ethical realm. It is reason, which is not the moral equivalent of scientific facts or evanescent wishes about the way things ought to be that will be the most reliable guide to the future.

In this day when my university emphasizes strongly that the ability to attract external support will be a major factor in hiring decisions for new faculty, the role of reason, central to ethics, seems to be losing its primacy to market interests. The role of higher education institutions now seems to be shaped almost exclusively by the wants of students seeking educational credentials, and businesses and government agencies seeking research outcomes (Zemsky, 2003). "When market interests totally dominate colleges and universities, their role as public agencies significantly diminishes—as does their capacity to provide venues for the testing of new ideas and agendas for public action" (Zemsky, 2003). We may be losing the understanding that as good and as powerful as our science is, knowledge has more than just instrumental value (Zemsky, 2003). What is lost is the ability to recognize that "what we should know, pretend that we know, and wish that we knew, we don't. Worse still, we do not know, without risk of embarrassment, how to ask about what we need to know" (Gomes, 1996, p. 4). Ideas and values are important whether or not they have marketability or confer

personal advantage. Universities are the traditional and best places to generate ideas and discuss values. They are the places to begin to ask about what we need to know. One of the things those engaged in agriculture continually need to explore is how to ask and respond to the many ethical challenges agriculture faces.

This book is written by one whose career has been in agriculture. It is not a philosophical text although it uses philosophical language and concepts and focuses on ethics. The book does not attempt to deal with all of agriculture's scientific and ethical challenges. Several important topics have not been discussed: agriculture and world population growth, urbanization and loss of agricultural land, the implications of limited water supply for future food production. Animal ethics have been discussed well by others (e.g., Cavalieri, 2001; Rollin, 1995; Singer, 1975; Thu & Durrenberger, 1998; Varner, 1998) and will not be covered herein. Foreign food aid is an important ethical question that affects agriculture but because of its complex policy and political dimensions, it too has not been included (see Aiken & LaFollette, 1996; Lappé et al. 1981). The ethical questions raised by the kinds of food we eat and those who provide it are well covered elsewhere (e.g., Cook, 2004; Schlosser, 2002) and have been omitted.

A second important purpose of this book is to seek the counsel of agricultural colleagues who care to offer comments and guidance. I ask, *Quid vobis videtur?*—How does it seem to you?

The first chapter explores the differences between scientific and experiential truth and discusses why that difference is important, to thought about the ethics of agriculture. Chapter 2 asks what kind of agricultural research ought to be done and questions the past orientation of agricultural science. Agricultural science has tended to keep the domain of scientific inquiry dissociated from the rest of the world and from human experience. This has resulted in affirmation of the incorrect thought that science is value free. Because of the frequent negative and well known effects of agricultural technology and the fact that agriculture is the single largest and most ubiquitous human interaction with the environment, its science is feared by many, and disparaged by some. Therefore the chapter concludes with advocacy of several appropriate changes in agriculture. Chapter 3 explores the problems that have developed due to agricultural technology and examines some of the responses when things go wrong and bad results occur. The discussion questions the dominant view that whatever problems technology creates will be solved by new technology. The importance of recognizing the limits of scientific knowledge and the need to adopt a broader integrative approach to managing complexity, one that allows for surprises and values ethical considerations is emphasized. This is especially important in societal debates about whether or not to interpret evidence in a precautionary framework that seeks to minimize false judgments that no hazard exists when in fact one does. Chapter 4 is an introduction to ethics intended for non-philosophers. It is not intended to be an in-depth exploration. The chapter claims that ethics

is regarded by agricultural scientists as something that is peripheral to the conduct of their science, rather than central. It is regarded as something that is purely academic and it should not be. References are provided for those who want to explore ethics in greater depth. Chapter 5 suggests that those engaged in agriculture possess a definite but unexamined moral confidence or certainty about the correctness of what they do. The chapter examines the origins of that confidence and questions its continued validity. The chapter argues that the basis of the moral confidence is not obvious to those who possess it or to the public. In fact the moral confidence that pervades agricultural practice is potentially harmful because it is unexamined. Suggestions for re-moralizing agriculture are made to approach the questions of where moral values originate and what are or ought to be the moral standards for agriculture in our post-industrial, information age society. The chapter advocates analysis of what it is about our agriculture and our society that thwarts or limits our aspirations for agriculture and needs modification. Chapter 6 attempts to establish the relevance of ethics to modern agriculture. Once again the text is directed at agricultural people not professional philosophers. The agricultural relevance of five moral theories is discussed and utilitarianism is proposed as the theory that dominates agricultural thought, although it is largely unexamined within agriculture. Chapter 7 discusses sustainability, including its definition, the moral case for achieving sustainability, and why it must be achieved. Chapter 8 tackles the still evolving, controversial topic of agricultural biotechnology. The chapter outlines the debate and describes the current regulatory situation here and elsewhere. Arguments in favor of and opposed to biotechnology are presented followed by some moral argument. The potential effects on family farms, academic-industry relationships, and transgenic pharming are discussed. The final chapter (9) asks how should we proceed. It begins with a discussion of seven agricultural problems and how agricultural/scientific mythology interacts with them. The chapter concludes with presentation of the imperative of responsibility and the task of finding partners as we proceed into the future.

Let us begin to explore agriculture's ethical horizon. It is my hope that the exploration will facilitate navigation through complex issues and serve as a guide to ways to construct common ground for resolution of agriculture's many ethical issues.

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CHAPTER 1

The Horizon of Agricultural Ethics

"We should be on our guard not to overestimate science and scientific methods when it is a question of human problems; and we should not assume that experts are the only ones who have a right to express themselves on questions affecting the organisation of society."

Albert Einstein

There are many differences in the words used and in the understanding of their meanings as one moves from the scientific to the experiential realm; from the laboratory where life's processes are studied; to the world where life is experienced. The words of scientific language are necessarily precise and understandable to other scientists, whereas the words of experiential language rarely have the same meaning to all.[1]

For example, a description of the common synthetic organic herbicide (2,4-dichlorophenoxy)acetic acid (2,4-D) might use these words: 2,4-D is a herbicide composed of a benzene ring with a chlorine atom in the ortho (2) and para (4) positions. An acetic acid moiety is connected to the benzene ring in the 1 position via a phenoxy (oxygen) link. The herbicide's mode of action is that of a persistent auxin whose concentration cannot be controlled by susceptible plants. Most broadleaf species (dicotyledons) are susceptible (i.e., their growth is severely reduced or they may die) and most grasses (monocotyledons) are not. Several formulations of 2,4-D are available and they can be used for selective weed control in wheat, barley, oats, rye, sorghum and field, and sweet corn. The molecular formula is $C_8H_6Cl_2O_3$ and the molecular weight of 2,4-D acid is 221.04. Epinastic symptoms in susceptible plants occur within a few days after application and absorption through roots or shoots. Susceptible plants die within 3 to 5 weeks. It is translocated in the symplast and metabolism occurs slowly.

[1] I am indebted to my colleague Dr. J. W. Boyd, Professor of Philosophy, Colorado State University, who guided me toward an understanding of the importance of language and models of truth.

2,4-D has a field half-life ($t_{1/2}$) in soil of 10 to 12 days. It leaches in soil but rapid microbial degradation in soil and plant uptake prevent leaching below 6 inches in most soils. Volatility occurs for some ester formulations but is typically negligible for acidic, salt, and low volatility ester formulations.

Another example is the description of the common simple perennial weed, dandelion. I suspect that all plant scientists and most homeowners know the common dandelion. The plant scientist (taxonomists in particular) properly calls it *Taraxacum* (the genus) *officinale* (the species) Weber in Wiggers (the authority). The authority is the name or designation of the person or persons given credit for first, unequivocally identifying and naming the species.

Dandelion is a member of the lettuce tribe of the sunflower or *Asteraceae* family. It was introduced to the United States from Europe. It is a deep-rooted simple perennial that reproduces by seed and, if cut, asexually from its tap root. The plant has a bitter, milky latex in all parts. The leaves are all basal, 2 to 12 inches long, and are lightly pubescent especially beneath and on the midvein. The leaves sometimes form a flattened rosette, and other times are more or less erect. They are oblong to spatulate and deeply and irregularly cut. Leaves are coarsely pinnatified, sinuate-dentate, and rarely subentire. The paired lobes or divisions are somewhat acute. The inflorescence is bright golden yellow to orange, 1 to 2 inches across, containing 150 to 200 ray florets. Involucral bracts are not glaucous but the outer ones are elongated and conspicuously reflexed. Each composite flower is borne on a hollow stalk, 2 to 18 inches tall. At maturity they form white, fluffy, seed bearing blowballs, about 1½ inches in diameter. Achenes are gray to olive-brown, ⅛ inch long, ridged, oblong, bluntly muricate, and bear a silky white pappus. Dandelion is distributed throughout the world's temperate and tropical zones.

A child and most adults who read such descriptions of the herbicide 2,4-D or the weed, dandelion, would probably regard them as nearly incomprehensible. Both descriptions are correct statements of scientific truth. That is to say that both are rational, publicly verifiable, easily falsifiable, literally true, definitive, and specific. These characteristics describe the language of science. Rationality, based on or derived from experiment and observation, is a cornerstone of scientific language. Often the language is mathematically based and precise. The language and the truth it represents are publicly verifiable, a hallmark of good science. Scientific findings—the result of research—are published in open, accessible journals and can be verified or denied by others. The meaning of the words in research reports is precise, when one understands them, and that understanding is available to anyone with a glossary of terms, a dictionary, or the right textbook. The language is definitive in that the words define 2,4-D, but not any of several other herbicides and dandelion, but not other common dicotyledonous plants.

The language of rationality is the ideal model of objective scientific truth. But what of the child who picks the pretty, yellow dandelion flower or blows the

pieces (the pappus) from the gray-white puffball of the mature flower and watches them float away and settle on the ground? What of the adult who has heard of 2,4-D and may even have used it to kill dandelions in the lawn but is concerned about it and all pesticides and their possible effects on human and environmental health? Scientifically rational language may speak to them but usually does not address what they see and feel. The language of rationality and the model of scientific truth is not adequate to describe the child's experience or the adult's attitude. The flower's attraction, its beauty, the fun one can have with it, and one's concern, perhaps fear, about a herbicide and its possible side-effects, require a different language—the language of experiential truth.

The language of experiential truth is personal and subjective. It is purposefully vague and because it is so personal, it is not subject to public verification. My granddaughter told me as I was using 2,4-D to kill dandelions in my lawn, that she thought dandelion flowers were really pretty. Words such as pretty, playful, concern, and possible effects, are imprecise. The language of experiential truth is rich in meanings because it is non-literal, symbolic, and dependent on the personal subjectivity of the speaker, which scientific truth wants to diminish, if not eliminate. Subjective, personal opinions are least worthy of consideration in a model of scientific truth but have the highest importance in a model of experiential truth.

When my granddaughter picked and showed me "the pretty dandelion flower," I realized quickly that my rapport with her in the midst of the flowers (or were they just weeds?) would have been damaged by the scientific response—"Well, actually what you think is a flower is not a flower at all. It is a complex inflorescence that is composed of several ray florets, etc." My rational, precise, literal, publicly verifiable words would have fallen on deaf ears or on no ears at all as she wandered off to pick more pretty flowers. My relation to her is durable but my relation with her at that moment would not have been improved. My focus on correct, scientific, exterior data would have clashed with her focus on her interior consciousness about dandelion flowers.

Among the models of how truth can be perceived, the scientific model is valued by the scientific community, all of whom also know experiential truth, but many of whom have not considered the differences, place, and value of each model of truth. The order of value in the scientific model is:

1. Rational truth —Can be defined mathematically, is publicly verifiable, literal, definitive, and precise.
2. Relational truth—Exterior data take precedence over one's interior consciousness of the relationship of one observation to another.
3. Personal truth —The realm of subjectivity is least worthy of being called scientific truth.

A model of experiential truth reverses the order and importance of the two models of truth.

1. Personal truth —Is of the most importance but the language is vague, imprecise, non-literal, symbolic, descriptive, and highly subjective, yet representing the greatest value.
2. Relational truth—Interior consciousness determines what one sees and how it is described and valued. Exterior data concerning the relation of one observation to another are interpreted subjectively.
3. Rational truth —Is present, but has the lowest value as a determinant of what is true.

SCIENTIFIC TRUTH AND MYTH

Many citizens of the world's developed countries are very well connected to their work. One sees examples everywhere: palm pilots, cell phones with internet access, pagers, fancy watches that tell time and connect to e-mail. Cell phones are now fashion statements and cameras as well as links to the daily grind (Coleman, 2000). Those who possess these marvelous technological achievements assume they lead to greater efficiency, productivity, perhaps even more importance, and, of course, greater happiness. Another view says that we are so connected that we never can be disconnected. Proximity and constant connection reduce the time available to disconnect. Such time is required to think and reflect and to see where we have been so we can determine where we ought to go (Coleman, 2000). Most agricultural scientists are well connected models of efficiency and productivity. However, they are often so busy being productive that direction becomes secondary or lost. Gallopin et al. (2001) suggest that there is a growing feeling (not a scientific certainty) that in spite of the marvels of communication and the appearance of efficiency and productivity, agricultural science is not responding adequately to the challenges of our time. Many of those engaged in agriculture are aware of the critique. However, those engaged in agriculture operate within the usually unexamined (frequently because it is unknown), guiding myth that increasing production and profit is the proper (perhaps the only) goal for agriculture. Those who criticize agriculture and agricultural science, its practitioners claim, do not understand their importance; the essentiality of the mission.

It takes effort for any group to become aware of its guiding myths and then to gain sufficient intellectual distance from the myths so they can be examined dispassionately. The difficulty is compounded by the fact that groups believe strongly in the value of the governing myth, even though it is generally unexamined and, the fact that in science, admission of the existence of a guiding myth is so foreign to the scientific method that scientists dismiss discussion of such things because they are not scientific and inherently subjective. Which is to say that such discussions lie in the arena of personal as opposed to rational truth. Asking agricultural scientists to describe the myths that guide their science is like

asking a fish to describe water. The myth for the scientists, like the water for the fish, is just there. It is the nature of a myth that those who hold it do not believe it to be a myth (Bronowski, 1977, p. 21). In fact, myth and science are like first cousins who strongly resemble each other and passionately hate the resemblance (Alexie, 2003).

Agriculture's practitioners seem to be so preoccupied with the vision of the necessity, indeed the responsibility, of continuing to increase production so the world's people will be fed that they do not pause to reflect on means (Midgley, 2002, p. 36). To properly criticize alternative visions of agriculture's present and its future:

> "we need to compare those visions, to articulate them more clearly, to be aware of changes in them, to think them through so as to see what they commit us to. This is not itself scientific business, though of course scientists need to engage in it. It is necessarily philosophic business (whoever does it) because it involves analysing concepts and attending to the wider structures in which those concepts get their meaning."
>
> (Midgley, 2002, p. 36)

The philosophic process of analyzing concepts will lead toward a just and realistic balance among competing visions of agriculture's future. The process will include consideration and analysis of scientific and experiential truths. The scientific view will, of course, not be hostile to science, but the point of view that includes experiential truth should also not be regarded as hostile. It is potentially a wider point of view from which science and our scientific myths arise and that provides support for them. The purpose is to strive for rational analysis to achieve what Midgley (2002, p. 37) calls "a just and realistic balance among our various assumptions and ideals."

> "The scientific point of view is itself an abstraction from it. The scientific angle is the one from which we attend only to certain carefully selected abstractions which are meant to be the same for all observers. When we move away from that specialized angle to the wider, everyday point of view we are not 'being subjective' in the sense of being partial. Instead we are being objective—i.e. realistic—about subjectivity, about the fact that we are sentient beings, for whom sentience is a central factor in the world and sets most of the problems that we have to deal with."
>
> (Midgley 2002, p. 101)

Agriculture and all its sub-disciplines (soils, animals, breeding of plants and animals, entomology, plant pathology, weed science, etc.) are guided by a core mythology—an arena of experiential truth, which, I claim, is usually unknown and unexamined. Such mythologies are not myths in the sense of lies or in the colloquial sense of a false tale, but imaginative visions or pictures that express a belief and appeal to the deepest needs of our nature (Midgley, 2002, p. 200)—our need for myth (May, 1991). They are essential. In agriculture and in life, we

cannot live without myths. A lack of myths would break our required links to the past; we would become uprooted from the past and from our own society. It is our myths that may or may not be founded on fact, that capture human imagination so powerfully. They are one way we order our and other's experiences. It is an essential way we use to order our world that is not exhaustive (Midgley, 2000, p. 101). It is best when considered with other views, other ways of ordering and interpreting the world.

Scientific truth, spoken in empirical language, refers to objective facts, whereas myth refers to experiential things, the quintessence of the human experience that gives meaning and significance to life (May, 1991, p. 26). When we examine our myths, we automatically move away from the realm of scientific truth, but that does not mean one dismisses scientific truth. The examination of guiding myths often compels questions that cannot be answered easily and may not be answerable at all. It is the asking that is cathartic (May, 1991, p. 284).

Part of our knowledge about scientific agriculture includes some level of certainty about the ability of technology to continue to solve problems as it has in the past. Technology, the knack of so arranging the world that we do not experience it (May, 1991, p. 57), can tell us what it is possible to do and perhaps how to do something but not why. Technology deals with the "what" of human existence rather than the "why" and it is the latter for which we are famished (May, 1991, p. 57). There is no question that scientific agriculture has solved many production problems. Part of the prevailing mythology of agricultural science is that the problems some identify as being caused by the science lie in the way the science and its associated technology are used and misused (what to do) but not with the scientific approach to problem definition or problem solving (why to do something) (Gallopin et al. 2001). No thoughtful agricultural scientist denies that soil erosion, soil salinization, pesticide resistance, pesticide presence in groundwater, and a host of other problems are real problems caused or exacerbated by agricultural technology. Few go on to the possibly cathartic question about "the existing rules of enquiry, and to what extent (and in which situations) the scientific rules themselves have to be modified, or even replaced" (Gallopin et al. 2001). That is, few go on to question the myth of the objectivity of the scientific method and how science is done. Science is criticized because of its use and misuse, but the model of scientific inquiry is not usually questioned. Gallopin et al. (2001) suggest it is necessary to consider modifying or replacing the fundamental rules of scientific inquiry in some situations, especially when it comes to study of agricultural sustainability, which requires integrating economic, social, cultural, political, and ecological factors. Sustainability (see Chapter 7) is not simply a scientific question and achieving it may require changing the rules of scientific enquiry.

Agricultural science has defined its domain as solving agricultural production problems. It is what scientists and technologists do. The world is a vast array of problems, many known and many unknown. The job of the scientist is to work

on and solve the problems the world presents (Gallopin et al. 2001). In close association has been what Gallopin et al. (2001) call a strong "privileging of the intended purpose" of the scientific enterprise. That is the intended outcome, the desired solution is consistently seen as good and likely, while the unintended side effects are ignored or dismissed as externalities[2] (Gallopin et al. 2001). There may be inconvenient or undesirable effects but they are relegated to another domain and are not the responsibility of the scientists who developed the technology or those who apply it. For example, herbicides were not designed or intended to leach to groundwater and their presence there is unfortunate but removing them is not regarded as the responsibility of those who develop, study, apply, or benefit from the herbicides used to control weeds in crops. The problem's solution is external to agricultural science, which strives to eliminate future problems but does not emphasize solving or apologizing for the problems created.

Tegtmeier and Duffy (2004) suggest, with adequate supporting data, that the negative external cost effects of crop and livestock agriculture in the U.S. are between \$5.7 and 16.9 billion each year. Crop production had negative effects between \$4,969 and 16,561 million annually, while livestock's negative externalities were \$714 to \$739 million per year. Their work was based on 417 million acres cropped in 2000.

Is a system that yields many external costs one that should remain unexamined for its defects or means of change? Is the method of scientific inquiry that contributed to the production of these external costs above question? The obvious answer is no. The complexity of the problems faced by agriculture and agricultural science is clear to all involved in agriculture. It is not a simple enterprise. The approach and the answer to many of the questions agriculture faces require value judgments. However, judgments of whether something is good or bad, right or wrong, decent or indecent are not easily answered within the scientific realm, with scientific truth. Such judgments are subjective and experiential and although they may be supported by reason, they are not totally dependent on scientific evidence. Scientific reasons alone are a poor guide to matters of value and judgment (Ehrenfeld, 1978, p. 223). Consensus about goodness may be reached, but it is not subject to proof or verification by science.

The problems of agriculture seem to multiply faster than the solutions. Gallopin et al. (2001) offer three reasons why things have become more complex. The *first* reason is ontological or human-induced changes in the nature of the real world. This is not just a twentieth century concern (see Marsh, 1965, 1864; Turner et al. 1990). Humans are a new force of nature (Lubchenko 1998) that modifies "physical, chemical, and biological systems in new ways, at faster rates,

[2] An externality is a cost that is not reflected in price, or more technically, a cost or benefit for which no market mechanism exists. In the accounting sense, it is a cost that a firm (a decision maker) does not have to bear, or a benefit that cannot be captured. From a self-interested view, an externality is a secondary cost or benefit that does not affect the decision maker.

and over larger spatial scales than ever recorded on Earth." For example, carbon dioxide emitted from the fossil fuels burned (mostly in the north) combined with carbon dioxide produced by deforestation (mostly in the south) has increased atmospheric CO_2 levels by about 20% over the pre-industrial background (Turner et al. 1990, p. 6). CO_2 and methane, whose atmospheric concentration has doubled since the mid-eighteenth century (Turner et al. 1990, p. 6), have become primary drivers of global climate change. Soil erosion continues from human and natural activity. "The overwhelming impression is that transfer of materials is changing the face of the earth at a faster rate than that at which the world's population is growing" (Douglas, 1990). More atmospheric nitrogen is fixed by humans than by all natural terrestrial sources combined (Vitousek et al. 1997).

The high productivity of modern agriculture is dependent on modifications of the Haber-Bosch synthesis of nitrogen fertilizer. About $^1/_2$ of all the nitrogen fertilizer used in all of human history has been used in the last 15 years (Clayton, 2004). This massive use has contributed to the growing hypoxic (O_2 concentration $< 2\,\mathrm{mg\,L^{-1}}$), dead zone (exceeding 20,000 square kilometers) (Postel, 2005) in bottom water of the Gulf of Mexico along the Louisiana-Texas coast. The hypoxic area, caused by effluent (mostly excess nitrogen fertilizer) from midwestern U.S. farm fields, is an example of ontological change caused by the quest for high-production agriculture (Goolsby et al. 2001; Rabalais et al. 2002). Mean annual nitrate N concentrations at St. Francisville, LA from 1980 to 1996 were more than double the average concentration from 1955 to 1970 (Goolsby et al. 2001). Hypoxia is not limited to the U.S. It has spread rapidly in recent decades and there are at least 146 areas in the world (Postel, 2005, p. 23). It has been cited as the "most widespread anthropogenically induced deleterious effect in estuarine and marine environments" (Diaz, 2001). More than half of all accessible freshwater is used by humans (Postel et al. 1996); most is used to irrigate crops and hypoxia is a common outcome.

The *second* reason (Gallopin et al. 2001) is epistemological change. Epistemology is the branch of philosophy concerned with the nature of knowledge. It is the study of the origin, nature, methods, and limits of knowledge. Essentially it is the study of the scope and foundation of knowing. Gallopin et al. assert that our understanding of the world has changed because modern science has made us aware of the behavior of complex systems, especially of their unpredictability. Surprise is part of the world's reality at the microscopic and macroscopic level. Scientists are coming to understand that ecology, in all its grand complexity, is a more important science then economics (Midgley, 2002, p. 188). Economics, including agricultural economics, has a role to play in measuring agriculture's future, but limiting definition of that role to economic analysis based on efficient use of resources is too limited because it ignores the human dimension of agriculture (Dundon, 2003, see Chapter 4). The focus of economic analysis is on developing a better society but economics often limits the purview of better to

price and profit. Madden (1991) suggests that focus must be expanded to "ethics and values far beyond those embodied in current market prices." This, of course, makes things more complex, less scientifically precise, and increases the significance of personal truth.

Much of what we need to know about agriculture is related to the behavior of complex ecological systems, about which we know little. Ecosystem services operating on generally unappreciated and unknown large and small scales are impeded by human activities and cannot be replaced by technological advances in agriculture as they have been in the past (Daily et al. 1997 as cited in Lubchenko 1998). The weed scientist who asks what herbicide will control weed X in crop Y is asking a good but incomplete question. It is a technical question that leads one to ignore or to assume that it is someone else's responsibility to ask questions such as:

What happens to the herbicide after it is applied?
What are the effects of attempts to remove the weed on the system?
Are weeds an inevitable concomitant of agriculture or is the weed there because of the way we have chosen to practice agriculture?

All involved in agriculture are aware of the *third* reason for added complexity offered by Gallopin et al. (2001): changes in the nature of decision making. A more "participatory style of decision making" is gaining and "technocratic and authoritarian" decision making is less in favor. The ecocentric, as opposed to technocentric view, often prevails. Other decision criteria (gender, human rights, the environment) are also gaining credibility as non-governmental organizations (NGOs) and multinational corporations expand the dimensions that define issues and solutions. In general, while changes in the nature of decision making are known and often lamented in agriculture, that knowledge has not led to changes in agricultural practice. Change in practice has been imposed from outside. It is reasonable to posit that changes resulting from environmental concern, gender issues, human rights, and animal rights have been resisted within agriculture.

Everyone is for agricultural sustainability (see Chapter 7). It has achieved the universally good status of God and motherhood. Even though all do not agree on what it is, there seems to be agreement that a sustainable agriculture must be economically successful. It also has to be ecologically, socially, culturally, and politically acceptable. Lubchenko (1998) said that the goal of obtaining a more sustainable biosphere means obtaining that which is ecologically sound, economically feasible, and socially just. She, as President of the American Association for the Advancement of Science, asked if the scientific enterprise that "had met these past challenges is prepared for the equally crucial and daunting challenges that lie in our immediate future." Her answer was, No, science is not prepared to meet future demands because "the real challenges facing us have not been fully appreciated nor properly acknowledged by the community of scientists whose responsibility it is, and will be, to meet them." Lubchenko (1998)

firmly says that it is time for the "scientific community to take responsibility for the contributions required to address the environmental and social problems before us, problems that, with the best intentions in the world, we have nonetheless helped to create."

The agricultural community knows that our modern agricultural system is very productive but not always profitable for those who produce. It has been quite profitable for corporations that create and sell agricultural technology and for many large farms. More than 30 years ago, Berry (1970, p. 78) noted the condition of the American farmer in an era of unparalleled affluence and leisure. His view of the condition of the American farmer is still valid.

> . . . the American farmer is harder pressed and harder worked than ever before; his margin of profit is small, his hours are long; his outlays for land and equipment and the expenses of maintenance and operation are growing rapidly greater; he cannot compete with industry for labor; he is being forced more and more to depend on the use of destructive chemicals and on the wasteful methods of haste and anxiety. As a class, farmers are one of the despised minorities. So far as I can see, farming is considered as marginal or incidental to the economy of the country, and farmers, when they are thought of at all, are thought of as hicks and yokels whose lives do not fit into the modern scene.

The modern agricultural system, created by the cooperative research of colleges of agriculture in the Nation's land grant universities and agribusiness companies, has done at least six things worthy of note. It has maintained food and fiber production while worsening the long-term health of soil and groundwater. Plant and animal genetic diversity have been reduced and the political and economic climate have reduced crop and livestock choice. The U.S. diet now favors animal over plant products. Our capital, energy, and chemically intensive production system requires high production volume at low cost and has driven small and medium sized farms out of business. Many colleges of agriculture faculty members will claim that their work was not intended to create this kind of system and in fact did not create it. This may be true and, if it is, one must ask what these faculty members were doing. Perhaps their work was irrelevant to the creation of the modern agricultural system the above characteristics describe. One cannot be sure. Therefore, we must ask, as Lubchenko (1998) did, if the challenges "facing us have not been fully appreciated nor properly acknowledged by the community of scientists whose responsibility it is, and will be, to meet them?"

We must continually ask the cathartic questions. What should we do? What is the agricultural research task? What are the questions we ought to be asking? Maintenance of production and, presumably, profit have been the premiere goals of agricultural research and of colleges of agriculture. Production has been maintained and even increased for most crops, grower profit has not, except for some large farms. We must explore whether this has been a proper and sufficient goal, and if it is the proper goal for the future?

Those engaged in agriculture must begin to examine and expand agriculture's ethical horizon. Most people think of a horizon as the apparent line where the sky meets the earth. A horizon can also be regarded as a limit or the extent of one's outlook, experience, interest, knowledge, etc. In the same sense as the earth-sky horizon, our intellectual horizon is what separates, divides, binds, and defines us. Our intellectual horizon is the full range or widest limit of our perception, interest, appreciation, knowledge, and experience. It is the intellectual horizon that those engaged in agriculture must examine and it is a major purpose of this book to explore agriculture's intellectual horizon, particularly as our collective, yet unexamined, ethical position, may limit what agriculture's ethical horizon defines.

Lubchenko (1998) concludes with a Calvin and Hobbes cartoon (Watterson, 1992). Watterson, through Calvin and Hobbes, has been a perceptive commentator on our society and his observations apply to our agricultural and general scientific dilemma.

Calvin and Hobbes are careening through the woods in their red wagon.
Calvin: "It's true, Hobbes, ignorance is bliss!
Once you know things, you start seeing problems everywhere . . .
. . . and once you see problems, you feel like you ought to try to fix them . . .
. . . and fixing problems always seems to require personal change . . .
. . . and change means doing things that aren't fun!
I say phooey to that!"
Moving downhill, they begin to go faster.
Calvin (looking back at Hobbes): "But if you're willfully stupid, you don't know any better, so you can keep doing whatever you like!
The secret to happiness is short-term, stupid self-interest!"
Hobbes (looks concerned): "We're heading for that cliff!"
Calvin (hands over his eyes): "I don't want to know about it."
They fly off the cliff: "Waaaugghhh!"
After crash landing,
Hobbes: "I'm not sure I can stand so much bliss."
Calvin: "Careful! We don't want to learn anything from this."

In contrast to Calvin and Hobbes, we bear a responsibility to ask what do we know and what must we learn from the agricultural experience and the limits of agriculture's ethical horizon? What are we responsible for that we can be proud of and what are we responsible for that we regret? We must learn how to ask as Eliot did:

> Where is the wisdom we have lost in knowledge? Where is the knowledge we have lost in information?
>
> T. S. Eliot, 1934
> Choruses from "The Rock"

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The Conduct of Agricultural Science

> *"The mistrust of science—the fear that people with an impenetrable language of their own are tinkering with things that are better left alone—has always run deep. In the best of cases scientists have responded to this fear head on, encouraging discourse, publicly exploring the limits and the unknowns."*
>
> Cohen, 2002

All educated people know something about science, about what it does and what it is. Exactly what science is and what it does, is not elusive but it is not easy to find a single definition that satisfies all. Below are a few of the many available:

Science among us is an invented cultural institution, not present in all societies, and not one that may be counted upon to arise from human instinct. Science exists only within a tradition of constant investigation of the natural world.

Eiseley, L. *The Man Who Saw Through Time*. C. Scribner's Sons

Science is the organization of knowledge in such a way that it commands more of the hidden potential of nature.

Bronowski, J. 1956. *Science and Human Values.* Harper and Row.

Science is a way of thinking much more than it is a body of knowledge.

Sagan, C. 1974. *Broca's Brain*. Random House.

Science is the study of those judgments concerning which universal agreement can be obtained.

Campbell, N. 1921. *What Is Science?* Dover Pub.

Science is the attempt to make the chaotic diversity of our sense experience correspond to a logically uniform system of thought.

Einstein, A. 1940. Conversations concerning the fundamentals of theoretical physics. *Science* 9:487.

Science: systematized knowledge derived from observation, study, and experimentation carried on in order to determine the nature and principles of what is being studied. A branch of knowledge or study, especially one concerned with establishing and systematizing facts, principles, and methods, as by experiments and hypotheses.

Webster's New World Dictionary of the American Language. 2nd College Ed. 1970.

For Lewis Thomas (1973), one of our ages most careful observers of science, especially medical science, the process was far more interesting than the definition.

> Scientists at work have the look of creatures following genetic instructions; they seem to be under the influence of a deeply placed human instinct. They are, despite their efforts at dignity, rather like young animals engaged in savage play. When they are near to an answer their hair stands on end, they sweat, they are awash in their own adrenalin. To grab the answer, and grab it first, is for them a more powerful drive than feeding or breeding or protecting themselves against the elements. It sometime looks like a solitary activity, but it is as much the opposite of solitary as human behavior can be. There is nothing so social, so communal, so interdependent. An active field of science is like an immense intellectual anthill; the individual almost vanishes into the mass of minds tumbling over each other, carrying information from place to place, passing it around at the speed of light.
>
> There is nothing to touch the spectacle. In the midst of what seems a collective derangement of minds in total disorder, with bits of information being scattered about, torn to shreds, disintegrated, reconstituted, engulfed, in a kind of activity that seems as random and agitated as that of bees in a disturbed part of the hive, there suddenly emerges, with the purity of a slow phase of music, a single new piece of truth about nature. In short, it works. It is the most powerful and productive of the things human beings have learned to do together in many centuries, more effective than farming, or hunting and fishing, or building cathedrals, or making money.

Thomas (1974) describes the planning and conduct of medical science and his description is, in many ways, precisely analogous to the agricultural experience. Agricultural scientists, farmers, and ranchers generally think of agriculture as an essential, immensely productive, successful enterprise. But, one can argue that it is not successful, because while productivity has been maintained, profit has declined, and many small-scale producers have suffered and disappeared. Busch and Lacy (1986, p. 77) point out that "the core agricultural science community remains surprisingly homogenous, despite new entrants from divergent

backgrounds." The core community represents "an impressive array of traditional American values: respect for independence, initiative, cooperation, hard work, usefulness, pragmatism, education, science, nature, age, experience, and tradition" (Busch & Lacy, 1986, p. 77). The agricultural community is a community of shared values that are rarely questioned from within. These values have enabled the community to withstand, perhaps even ignore, external questions about agricultural technology that has improved lives and worked in the service of all humanity by feeding people. This is true even though much of the technology has generated private profit and external effects that are not borne by the developers or adopters of the technology (Busch & Lacy, 1986, p. 271; Tegtmeier & Duffy, 2004).

Within agriculture, the green revolution of the 1960s is generally regarded as a great success. New high-yielding varieties of wheat and rice increased yields around the world and more people were fed; massive starvation was avoided. A doubly green revolution has been proposed (Conway, 1997) to address the world's continuing problem of feeding all people. All have a demand for food and some are not fed, neither because they do not have a need for food nor because too little food is produced. People are not fed because they have ineffective demand. They are poor, without money to buy food or land to produce it. Conway (1997, p. 42) suggests reversing the goals of the first green revolution. The doubly green revolution should begin with the socio-economic demands of poor households and then seek to identify appropriate research priorities. The goal would not be to produce more food, although that is not a trivial goal, but to create food security and sustainable livelihoods for the poor. It is too soon to know if Conway's shift in emphasis has been accepted or if it will be effective. In developed countries, the public view, if agriculture is thought of at all, is that agriculture must be successful, because the grocery store is always full of food. That is not the view in or from the world's developing nations.

A more nuanced view expresses uncertainty about agriculture's past and future technology, e.g., pesticide use, genetic modification, animal confinement and of agriculture's perceived results: loss of small and medium sized farms and rural communities, soil erosion, groundwater mining, pesticide contamination of food and water, and continued hunger in the U.S. and the world. There seems to be a disconnection between the ability of agricultural research to increase productivity and the application of that knowledge to human and environmental problems. The grocery stores in the U.S. remain full but people are still hungry here and elsewhere. Developed country agriculture remains enormously productive but its productive techniques and their results compel questions about its goodness. The U.S. Congress passes enormous agricultural subsidy appropriations but "the rural home and rural life"[1] suffer and disappear. These kinds of challenges to agricultural science cannot be answered by science alone but they should not be ignored by agricultural scientists.

[1] This is the language used in the Hatch Act, United States Code, Section 361b.

Similar to Thomas' (1974) claim for medical research, in agriculture it is understood specifically targeted research goals are required. The problem or problems to be solved must be identified clearly and it will be best if the problem can be addressed and solved in a 2- or 3-year funding period. It is good to have clear targets—well-defined problems that can be solved in a short time—so we can move on to other clear, well-defined problems. A critical aspect of this approach is that it assumes that basic biological and agricultural knowledge has "a much greater store of usable information, with coherence and connectedness, than actually exists" (Thomas, 1974, p. 116). The tendency in agricultural research has been to proceed without the basic knowledge and, so far, it has been quite successful. For example, in weed science most weeds (not all) can be controlled in most crops. Complete life histories of weeds are rare (they are generally just annuals, biennials, or perennials). Why a weed grows where it does is less important than how to control it. The fact that the empty ecological niche created by control will be filled by another weed, which keeps the cycle of control going, is not regarded as even a minor problem. Weed scientists have demonstrated over and over again that controlling one weed well, means that another must be controlled, but they persist in applying the same technological control methods without ever really appreciating the problems they create. Technological application rules weed science, which continues to advocate applying herbicides to solve weed problems while expecting better results and fewer problems from each new herbicide. Thomas (1974) noted that early medical science was hoaxed by bleeding, cupping, and purging and, more recently, by overuse of antibiotics. All were used with the best of good intentions and all failed to some degree because of lack of understanding of the etiology of disease.

The great achievement of weed science and other pest control disciplines has been development of diverse technologies to control weed/pest infestations in most crops. That ability in weed science began with the development of selective organic herbicides subsequent to World War II. It was not preceded by extensive, painstaking, laborious, demanding research on weed biology and ecology. This history stands in sharp contrast to medical research where years of work on disease etiology demonstrated [in Thomas' (1974) words] "bits of information being scattered about, torn to shreds, disintegrated, reconstituted, engulfed, in a kind of activity that seems random and agitated." All of this necessarily preceded the advent of antibiotics.

Weed science research proceeded with a limited basic biological and ecological foundation. The primary approach to solving today's important unsolved weed problems (e.g., parasitic weeds, perennial weeds) remains application of the chemical technology that has been used successfully to solve annual weed problems. The environmental, human health, and non-target species effects remain largely unaddressed, ignored, or externalized and the crucial biological and ecological information to address these things is unavailable or appearing only slowly. Medical science has demonstrated repeatedly that the direct, frontal approach to

disease does not work.[2] Weed science illustrates the agricultural penchant to continue to rely on that approach.

Thomas (1974, p. 118) notes that the element of surprise is what marks the difference between applied and basic science. Agriculture, especially in the pest control disciplines, has been well organized to establish targets, apply knowledge, and produce a usable product. This procedure requires a high degree of certainty. The facts on which protocols are based must be reasonably certain with unambiguous meaning. Pesticide development is a good example. The work is planned and organized so the result (a product that works) will be obtained. There is a central authority, elaborate time schedules, and a reward system based on speed and perfection. Much pest control research has been of this kind.

Basic research is the opposite. It begins with a high degree of uncertainty, otherwise Thomas (1974) asserts, "it isn't likely to be an important problem." The initial facts are incomplete and ambiguous. The challenge may be to find the threads of connection between unrelated bits of information. Experiments are most often planned on probability rather than certainty and results are uncertain, surprise is common. If one did a survey of agricultural research over the last several decades the data would show a strong emphasis on applied studies. This is an observation of fact not a criticism. The results of the volume of applied work have been impressive. For example, the world now feeds more people a better diet than ever before. Conway (1997, p. 44) notes that in the mid-1960s about 1 billion people (50% of the population) in developing countries did not get enough to eat. Today less than 20% of the people in developing countries do not get enough to eat, but the growth of world population (6.4 billion in 2005 and projected to be almost 8 billion in 2025) means there are now 1.2 billion people who do not get enough to eat.

I agree with Thomas' (1974, p. 119) assessment of medical research and suggest his thoughts are directly applicable to agricultural research—"the majority of important research to be done is in the class of basic science. The new mass of knowledge is still formless, incomplete, lacking the essential threads of connection, displaying misleading signals at every turn, riddled with blind alleys" (Thomas, 1974, p. 119). If the assessment is correct for agricultural research, it portends a difficult and exciting change.

It is correct to posit that the primary emphasis of agricultural research for many decades has been to increase grower's productivity and profit. It is also reasonable to assume that agricultural scientists and farmers have other goals. Applied research has had a higher priority, a higher value, than basic research (Busch & Lacy, 1986, p. 15). That is they value achieving other things. They and most people

[2] An example is the tendency to favor pharmaceutical remedies over physical or psychological therapies that may be better solutions to chronic pain see Walllis, C. 2005. The right and wrong way to treat pain. *Time*, Feb. 28, pp. 46–57.

want to create a good world.[3] Such a world will be one that is just, peaceful, generally prosperous, democratic, free of prejudice of all kinds, and humane. It may also be other things. Within the agricultural context, to create a good world, agriculture has some specific responsibilities. These include:

1. Achieving sustainable production practices.
2. Decreasing pollution.
3. Eliminating excessive soil erosion.
4. Eliminating harm to other plant and animal species.
5. Ending habitat destruction (see Green et al., 2004).
6. Ending species extinction.
7. Ending water pollution and mining for irrigation.

There are other values one could include to create a good world (e.g., ending war, empowering women and minorities, creating more equitable social arrangements, etc.) but these are not things that fall directly within agriculture's purview. To begin to work on the problems that agriculture can work on, we must learn how. Maxwell (1992) argues that the academic enterprise, of which agriculture is a part, is "devoted by and large to improving knowledge and technological know-how"—which from "the standpoint of helping us create a good world, is grossly and damagingly irrational." What is produced merely increases our power to act without affecting our power "to act humanely, cooperatively, and rationally" (Maxwell, 1992). Modern technology that permits one person to do the work of a thousand also permits that person to wreak the environmental havoc of a thousand (Peterson, 1978).

New goals for agriculture require a new kind of inquiry, which pursues scientific truth but simultaneously has humane goals. It is an inquiry that is specifically value-laden. Its basic aim is to improve knowledge and "personal and global wisdom" (Maxwell, 1992). Wisdom in this context is "the capacity to realize what is of value in life, for oneself and others." Wisdom includes knowing how to do X, knowing why it is good to do X, and why it is good to do X rather than Y or Z.

The philosophy of knowledge as it has been inherited from Sir Francis Bacon, the scientific revolution of the sixteenth and seventeenth centuries, and the Enlightenment of the eighteenth century represent the unspoken scientific, intellectual creed adopted whole by agricultural scientists. It is a widely held ideal of the scientific enterprise as it is practiced in the academic and industrial worlds (Maxwell, 1992). In its simplest form one defines a problem, does the appropriate research and arrives at a management solution that can be applied within a

[3] The following definition of good is not intended to be precise or all inclusive. Good is an experiential term, not a precise, scientifically definable one.

policy framework (Walton et al., 2002). The essential problem with this philosophy of knowledge is that the fundamental methodological prescription is one that keeps the domain of scientific inquiry dissociated from the rest of the world and from human experience (Maxwell, 1992). It results in affirmation of the incorrect thought that science is value free. Only scientific truth can enter the domain of inquiry. Politics, religion, values, emotions, and desires (the realms of experiential or personal truth, see Chapter 1) are excluded because they must be. Economic considerations may be part of the management decision because the scientific solution proposed must, after all, be profitable or it won't be employed.

Maxwell (1992) proposes that the reason this is the dominant view is that "the intellectual aim of inquiry is to improve knowledge" of scientific truth. This can only be achieved when "we allow only those factors relevant to the assessment" of scientific "fact and truth to influence . . . choice of results and theories." When the scientist allows an argument with a spouse, the misbehavior of children, strong feelings, the desire for promotion, political objectives, etc., to influence the choice of results and theories, scientific truth will be corrupted. Therefore, in this view, the scientist *qua* scientist must in the scientific intellectual domain, absolutely exclude all human value considerations. "Empirical success or failure alone must decide the fate of scientific theories" (Maxwell, 1992) and of each experiment. What a scientist chooses to study can be influenced by personal or societal factors but the evaluation of the data, the justification of the results, must never be.

Rudner (1953) claims the contention that scientists make value judgments is supported by the argument that having a science at all involves a value judgment. Selection among alternative scientific approaches to a problem involves a value judgment and scientists cannot escape their humanity, which influences all activities, including scientific ones. The criticism of these arguments is that while they all may be true they are extra-problematic (Rudner, 1953) in that they "form no part of the procedures involved in the scientific study of a particular problem." Such procedures, the essence of science, have not been shown to include any value judgments. Ergo, the scientific method is (must be) free of value judgments (a value claim). Scientists when engaged in the scientific enterprise strive diligently to omit personal idiosyncrasies and value judgments from the conduct of science (Rudner, 1953). However, Rudner (1953) argues persuasively that scientists *qua* scientists do make value judgments, although they may not be recognized as such. His first claim is that scientists accept or reject hypotheses and that this includes a value judgment. No scientific hypothesis is ever completely verified. Scientists use statistical inference to accept or reject hypotheses and the statistical evidence enables judgment about how strong the evidence is. How strong the evidence must be is often determined by the importance (the value) of the question being studied. If the scientist is asking if a pesticide will harm human health the evidence must be stronger than if one is asking if a new crop variety yields more. In agriculture (as in most of the scientific world) two levels of

confidence (1 or 5%) have become accepted by frequent use. These values represent the risk one is willing to assume and that is clearly a value judgment. Rudner (1953) notes that some object to this line of reasoning because it is "the function of the scientist *qua* member of society to decide whether a degree of probability associated with the hypothesis is high enough to warrant its acceptance. However the task of the scientist *qua* scientist is only the determination of the degree of probability or the strength of the evidence for an hypothesis and not the acceptance or rejection of that hypothesis. Rudner (1953) argues that the scientific method intrinsically requires making value judgments and for the scientist to omit this fact does not in any way contribute to scientific objectivity. To ignore the fact that value decisions are an inevitable part of science and to make them intuitively, haphazardly, or unconsciously is "to leave an essential aspect of the scientific method scientifically out of control" (Rudner, 1953).

Omission of value considerations and maintenance of the myth that science is value-free has been a problem in agricultural science. I agree with Rudner (1953) who argues that scientific objectivity should include thought about what value judgments are made or might be made and even about those that ought to be made. Full awareness of ethical matters is an essential part of scientific progress toward objectivity (Rudner, 1953). An operative philosophy, which excludes all but empirical success, has enabled agricultural scientists to produce scientific solutions rapidly to many production problems while simultaneously ignoring the problems the solutions create. The global problems mentioned in the introduction and the continuing agricultural problems mentioned above have not been solved and have become worse. It is undeniably true that agricultural production feeds more people than ever before but too many people (approximately 1.2 billion) still are hungry in a world with serious environmental problems, many exacerbated by the practice of agriculture (Green et al., 2004). Many of these problems would not exist were it not for modern agricultural practice. Solutions to the problems involve science, but the continued dissociation of science from human problems and from questions of value will assure that the "priorities of scientific research will come to reflect, not the interests of those whose needs are greatest, the world's poor, but the interests of the powerful and wealthy—First World rather than Third World interests" (Maxwell, 1992). In agriculture this is exactly what one finds—First world interests dominate.

WHAT RESEARCH OUGHT TO BE DONE?

The work of research is to find that "single new piece of truth about nature" (Thomas, 1973). The work of agricultural research includes discovering truth about nature and discovery, development and employment of new practices, techniques, and machines to improve agricultural productivity and profit. Both approaches to science are worthy of praise and support.

As noted in Chapter 1, a major purpose of this book is to explore agriculture's ethical horizon, particularly as our collective, yet unexamined, ethical position, may limit what that horizon defines. Given this goal, it is clear that scientific objectivity in discussions of what agriculture's ethical horizon is or ought to be, should include thought about what value judgments are made or might be made and about those that ought to be made. Part of the scientific enterprise is critical inquiry. That means doing experiments well with proper procedures and appropriate analysis of results. It also means examining what we think is known, to learn about what is not known. What is accepted as true and what is opinion must be questioned. "It is far easier to label than to understand, and intellectual laziness undermines our studies with deadly inversion of the scientific method: 'I'll believe it when I see it!' becomes 'I'll see it when I believe it" (Homerin, 2003).

It is a certainty that the ideas of science are remaking the world (Bronowski, 1977, p. 3). But there is nothing absolute about the ideas or concepts of science. They form a flexible framework that is always building and being rebuilt. The only thing the framework must fit, or adapt to, is the facts—the scientific facts. Bronowski (1977, p. 211) identifies a "tyranny of facts that distresses even intelligent people, who fear that the spread of science is robbing them of some freedom of judgment."

Because of its technology and the fact that agriculture is the single largest and most ubiquitous human interaction with the environment, its science is feared by many, and disparaged by some. Therefore, Maxwell (1992) advocated a move from a philosophy of knowledge to a philosophy of wisdom. In his view, a move toward a philosophy of wisdom demands several things that seem germane to appropriate changes in agriculture. Of the 15 changes Maxwell (1992) recommended, seven seem particularly applicable to agriculture. These are:

1. Academic problems must include the problems of living as intellectually more fundamental that the problems of knowledge.
2. Proposals for academic ideas need to change so they become proposals for action as well as claims to knowledge.
3. The definition of intellectual progress should be expanded from progress in knowledge to include progress in ideas relevant to achieving a sustainable, wise world.
4. The intellectual domain of science which has consisted of evidence and theory should be expanded to include research aims. Scientific discussion should be expanded to include discussion of the effects of scientific achievements on life; all life, not just human life. For example, the advent of pesticides in agriculture and their relationship to the state of the environment and the health of other creatures.
5. Social inquiry and natural (agricultural) science must be more integrated. For example, the social effects of agricultural technology often appear after adoption and should be considered before adoption.

6. The academic enterprise should not be intellectually dissociated from the world but "constantly learning from, speaking to, and criticizing society" (Maxwell, 1992) as they move together toward cooperative rationality and social wisdom.
7. Philosophy must cease to be a specialized discipline and become an integral part of all inquiry that is concerned with our most fundamental problems. Many of those fundamental problems are essentially agricultural. How can all people be fed? How should we practice agriculture? Is there a human right to food?

Philosophers will help people in agriculture seek answers to the "inordinate number of paradoxes, puzzles, and ironies" encountered in explorations of the agricultural enterprise (Perkins, 1997, pp. 3–4). These are not simple puzzles with clear, single solutions. They are complex issues that require the best science and the best philosophy. I include below Perkins' (1997) challenging questions raised by the practice of agriculture.

Agriculture was once the place where most people worked but now in the developed world it is the place where only a small minority of people work.

Agriculture feeds the world, but few people understand it or care much about how it works.

People think of agriculture as an activity that creates a landscape that is "alive, verdant, lush, and redolent of wholesome naturalness," but agriculture, humans' largest and most widespread environmental interaction, most often destroys natural ecosystems and wildlife habitat (Green et al., 2004).

Most people and "American political mythology" think, in the Jeffersonian tradition, that agriculture produces honorable farmers who are the backbone of the nation and a source of its cultural richness, but farmers and ranchers are generally regarded as backward country bumpkins who probably couldn't make it in the real world of American business (see Berry citation in Chapter 1).

Agriculture is a business but it is also "a human-created ecosystem generating a food-web of which we are an integral part and without which most of us could not survive."

Agriculture is not usually regarded as something that is essential to homeland security or the internal security of any nation. It is however as important as any activity in guaranteeing national independence because it is the activity on which all others depend.

Agriculture is usually perceived as a "romantic, tranquil refuge from the relentless blight of industrial civilization." It is far from tranquil as it is continually changed by the relentless advance of technology. Agriculture is "the foundation upon which the machinery of urban industry was built and is maintained."

The challenges Perkins (1997) poses are clearly not scientific or technical. The answers won't be found in any set of scientific data.

It is only one among many definitions, but technology can be defined as a set of predetermined operations that yield predictable results. For example, it is true that when one uses the right pesticide at the right time at the right dose, the susceptible pests die. When the right fertilizer is applied correctly crop yield will increase. But such simple relationships overlook the fact that using an agricultural technology has social, economic, and political ramifications that need to be identified and discussed. Full analysis also demands exploration of the philosophical dimensions of agricultural science and its technology. That is, in the classical sense, we must begin to logically analyze the principles underlying conduct, thought, and knowledge of the agricultural enterprise rather than just its productive results.

Agricultural science has focused on the agricultural (usually the yield increasing) end of its research. Ends may be analyzed to determine if they are good. But philosophical analysis means we are obligated to compare the end to the means to reveal their compatibility or lack thereof. The means contain the ends. Emerson (1937) said:

> "cause and effect, means and ends, seed and fruit, cannot be severed; for the effect already blooms in the cause, the end pre-exists in the means, the fruit in the seed."

The means contain only the natural end, which is not necessarily the end predicted or advocated by strong advocates.

HIGHLIGHT 2.1

"We need a corpus of people who consider that it is important to take a serious and professional crude look at the whole system" (Friedman (1999) quoting M. Gell Mann). It has to be a crude look, because you will never master every part of every interconnection. . . . Unfortunately, in a great many places in our society, including academia and most bureaucracies, prestige accrues principally to those who study carefully some (narrow) aspect of a problem, a trade, a technology, or a culture, while discussion of the big picture is relegated to cocktail party conversation. That is crazy. We have to learn not only to have specialists but also people whose speciality is to spot the strong interactions and the entanglements of the different dimensions, and then take a crude look at the whole. What we once considered the cocktail party stuff—that's the crucial part of the real story.

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When Things Go Wrong— Balancing Technology's Safety and Risk

> Feeding antibiotics to livestock helps the animals grow faster (for some unknown reason) and provides a preventive measure of protection against some health problems. On the other hand, this widespread use of antibiotics leads to "super bugs" through genetic selection, that can infect both livestock and humans. When a person contracts a drug resistant strain of a bug, standard methods of treatment are usually ineffective. The consequences are a more severe illness and possibly death. Thus, the continued feeding of antibiotics to livestock is not good for society.
>
> Any amount of benefit-risk assessment can be done to quantify the number of people who might die as a result of this agricultural practice. But the scientific approach fails to address whether any number of deaths is acceptable and thus right. Philosophy doesn't dispute the power of antibiotics. Philosophy addresses the concept of acceptable risk using reason about the morality of causing death in an otherwise healthy person because the treatment has been pre-empted for scientific, economic, and material gains of a few.
>
> See: http://www.missoulian.com/articles/2003/11/09/opinion/opinion1.txt

My first experience with herbicides for weed control was in Columbia County, in the Hudson Valley of New York state. Dr. S. N. Fertig, Professor of Weed Science in Cornell University's Department of Agronomy had given me, the assistant county agricultural agent, a small Hudson sprayer and several small, brown paper bags with differing amounts of white to gray powdery material in them. My instructions were to find a corn field, mark off four adjacent corn rows each 20 feet long, with four similar areas (four replications) for each bag of material. Then I was to put the material in the bag in the Hudson sprayer, mix it thoroughly with water, pump up the sprayer, and then spray the mixture on each of the four small plots before the corn emerged. Each numbered plot, marked with a white, wooden stake was in a corn field on the farm where I lived and I was able to observe them frequently. I do not recall how many different materials

were included or the specific rates used for each material. Given the application method, precise rates were probably not achieved. I do recall that some of the results of this simple experiment were absolutely astonishing to me. As the corn emerged, two sets of four plots were completely weed-free. Only corn grew and it grew well with no obvious detrimental effects from the herbicide. The year was 1958, the herbicide applied at two rates, separately to each set of four plots was among the first of the triazine herbicides—simazine. The results were magic. For the first time I had done field research that achieved marvelous results that I thought could eliminate the need to weed; a task no one liked. I was convinced of the potential of chemical weed control and similar to most others, in that time, did not consider possible disadvantages. In view of the magic of total weed control observed, I was not inclined even to try to think of any disadvantages. My memory is that no one even asked about possible disadvantages. The agricultural magic that I had facilitated, would inexorably lead me to my future, although I did not understand the implications of what that future would bring.

THE DEVELOPMENT OF HERBICIDES

The chemical era of agriculture really began after 1945, when new fertilizers and pesticides developed rapidly and became widely available. Increases in crop production and labor productivity were caused by mechanization, the use of agricultural chemicals, increased education of farmers, improved crop varieties, and improved farming practices. My simazine experience was not at the beginning of the rapid chemicalization of agriculture but it was close to the beginning.

The chemical era developed rapidly after WWII, but it began much earlier (see Committee on the Future Role of Pesticides in US Agriculture 2000, for a more complete history). In 1000 B.C. the Greek poet Homer wrote of pest-averting sulfur. Theophrastus, regarded as the father of modern botany (372?–287? B.C.), reported that trees, especially young trees, could be killed by pouring oil, presumably olive oil, over their roots. The Greek philosopher Democritus (460?–370? B.C.) suggested that forests could be cleared by sprinkling tree roots with the juice of hemlock in which lupine flowers had been soaked. In the first century B.C., the Roman philosopher, Cato, advocated the use of amurca, the watery residue left after the oil is drained from crushed olives, for weed control (Smith & Secoy, 1975).

History tells us of the sack of Carthage in 146 B.C. by the Romans who spread salt on the fields to prevent crop growth. Later, salt was used as a herbicide in England. Chemicals had been used as herbicides in agriculture for a long time, but their use was sporadic, frequently ineffective, and lacked any scientific basis (Smith & Secoy, 1975, 1976).

Bordeaux mixture, a combination of copper sulfate, lime, and water was applied to grapevines to control downy mildew. Someone (perhaps several

people) in Europe (no one knows who it was) in the late nineteenth century noted that when the mixture was used to control downy mildew, yellow charlock = wild mustard [*Brassica kaber* (DC.) L.C.Wheeler = *Sinapis arvensis* L.] the plant's leaves turned black. That led Bonnet, in France in 1896, to show that a solution of copper sulfate would selectively kill yellow charlock plants growing with cereals. In 1911, Rabaté demonstrated that dilute sulphuric acid could be used for the same purpose. The discovery that salts of heavy metals might be used for selective control led, in the early part of the twentieth century, to research on the use of heavy metal salts for weed control by the Frenchmen Bonnett, Martin, and Duclos, and the German, Schultz (cited in Crafts & Robbins, 1962). Nearly concurrently, in the United States, Bolley (1908) studied iron sulfate, copper sulfate, copper nitrate, and sodium arsenite for selective control of broadleaved weeds in cereal grains. Bolley, a plant pathologist, who worked in North Dakota, is widely acknowledged as the first in the U.S. to report on selective use of salts of heavy metals as herbicides in cereals. Succeeding work in Europe observed the selective herbicidal effects of metallic salt solutions and acids in cereal crops (Zimdahl, 1995).

Use of the inorganic herbicides developed rapidly in Europe and England, but not in the United States. Weed control in cereal grains is still more widespread in Europe and England than in the U.S. Reasons for slow development in the U.S. were lack of adequate equipment and frequent failure because the heavy metal salts were dependent on foliar uptake that did not readily occur in the low humidity of the primary grain-growing areas of the U.S. Other agronomic practices such as increased use of fertilizer, improved tillage, and new varieties increased crop yield in the U.S. without weed control. U.S. farming could move on to what many thought of as the endless frontier of new land and farmers were not as interested, as they would be later, in untried yield enhancing technology.

Petroleum oils were introduced for weed control along irrigation ditches and in carrots in the early twentieth century. Field bindweed (*Convolvulus arvensis* L.) was controlled successfully in France in 1923 with sodium chlorate, which is now used mainly as a soil sterilant in combination with organic herbicides. Arsenic trichloride was introduced as a product called KMG (kill morning glory) in the 1920s. Sulfuric acid was used for weed control in Britain in the 1930s. The first synthetic organic chemical for selective weed control in cereals was 2-methyl-4, 6-dinitrophenol (DN or dinitro), introduced in France in 1932 (King, 1966, p. 285). It was used for many years for selective control of some broadleaved weeds and grasses in large seeded crops such as beans.

Pokorny (1941) first synthesized 2,4-dichlorophenoxy acetic acid (2,4-D). Accounts vary about when the first work on growth-regulator herbicides was done (Akamine, 1948). Zimmerman and Hitchcock (1942) of the Boyce-Thompson Institute (now part of Cornell University) first described the substituted phenoxy acids (2,4-D is one) as growth regulators, but did not report

herbicidal activity. They were the first to demonstrate that these molecules had physiological activity in cell elongation, morphogenesis, root development, and parthenocarpy (King, 1966). A Chicago carnation grower's question about the effect of illuminating gas (acetylene) on carnations, led to the eventual discovery of plant growth regulating substances by Boyce-Thompson scientists (King, 1966).

E. J. Kraus was Head of the University of Chicago Botany Department and had worked with plant growth regulation for several years. He supervised the doctoral programs of J. W. Mitchell and C. L. Hamner who in the early 1940s were plant physiologists with the U.S. Department of Agriculture Plant Industry Station at Beltsville, MD. Kraus thought these new, potential plant growth regulators that often distorted plant growth when used at higher than growth-regulating doses, and even killed plants, might be used beneficially to kill plants selectively. He was the first to advocate purposeful application in toxic doses for weed control. Because of World War II, much of this research was done under contract from the U.S. Army and was directed toward discovery of potential uses for biological warfare against an enemy's crops. Similar work for similar reasons was done in Great Britain (Kirby, 1980; Peterson, 1967; Troyer, 2001).

Hamner and Tukey (1944a, b) reported the first field trials with 2,4-D for successful selective control of broadleaved weeds. They also worked with 2,4,5-T as a brush killer. At nearly the same time, Slade, Templeman, & Sexton (1945), working in England, discovered that naphthalene acetic acid at 25 lbs/acre would selectively remove yellow charlock from oats with little injury to oats. They (Slade et al. 1945) also discovered the broadleaved herbicidal properties of the sodium salt of MCPA (4-chloro-2-methylphenoxy acetic acid) (King, 1966), a compound closely related to 2,4-D. Slade et al. (1945) confirmed the selective activity of 2,4-D. Marth and Mitchell (1944), also former students of E. J. Kraus, first reported the use of 2,4-D for killing dandelions and other broadleaved weeds selectively in Kentucky bluegrass turf. These discoveries were the beginning of modern chemical weed control. All previous use of chemicals was just a prologue to the rapid development that occurred following discovery of the selective activity of the phenoxy acetic acid herbicides. The first U.S. patent (No. 2,390,941) for 2,4-D as a herbicide was obtained by F. D. Jones of the American Chemical Paint Co. in 1945 (King, 1966). There had been an earlier patent (No, 2,322,761) in 1943 of 2,4-D as a growth regulating substance (King, 1966). Jones patented only its herbicidal activity but made no claim about selective action (King, 1966).

The great era of herbicide development came at a time when world agriculture was involved in a revolution of labor reduction, increased mechanization, and new methods to improve crop quality and produce higher yields at reduced cost. Herbicide development built on and contributed to agriculture's change. Agriculture was ready for improved methods of selective weed control. As weed control developed the importance of methods changed, but no methods have

been abandoned. The need for cultivation, hoeing, etc. has not disappeared and these methods are still used in small scale agriculture. They have become less important in developed world agriculture because of the rising costs of labor and narrow profit margins.

Rapid development of pesticides occurred after WWII. In 1994 there were over 180 different selective herbicides in use in the world and several experimental herbicides in some stage of progress toward marketability (Hopkins, 1994). If proprietary labels are considered, there may be over 1000 chemical and biological compounds used for pest control in the world (Hopkins, 1994). In 1999, 1.2 billion pounds of pesticides were sold in the United States and 43% of that amount was herbicides, which represented 60% of the total dollar value (Donaldson et al. 2002). The total pounds of herbicides used has dropped somewhat in recent years largely due to widespread planting of herbicide resistant crops. The global pesticide market was 5.7 billion pounds (36% herbicides) in 1999 with a value of $33.6 billion. The U.S. market was $11.2 billion (Donaldson et al. 2002). About one-third of the world market for pesticides is in the U.S., Japan is the next largest national consumer. When the European market is considered as a whole, it is second largest, with France, the largest single pesticide user in Europe (Hopkins, 1994).

The world pesticide market in 1999 was 36% herbicides, 25% insecticides, and 10% fungicides. Worldwide herbicides were 43% of total sales (Donaldson et al. 2002). In 1990 the figures were 45, 28, and 20%, respectively (Hopkins, 1994). In 1997, almost 48% of the market was for herbicides (Asgrow, 1998). About 77% of all pesticides and 80% of herbicides are used in agriculture. The number of companies engaged in synthesis, screening and developing herbicides has dropped from a peak of 46 in 1970 to just seven large multi-national corporations[1] that control at least 90% of the international pesticide market. Only three of the corporations are American (DuPont, Dow Agro-Sciences, and FMC) (Asgrow, 1998). Nearly half the companies engaged in pesticide discovery in 1994 were Japanese (Hopkins, 1994).

PROGRESS OF WEED SCIENCE

In 1960 when I saw the magic of simazine for weed control in corn, there were some people who questioned the advantages of chemical weed control but I and those I knew were not among them. I thought I was joining what I saw as the march of progress toward reduced labor for weed control and increased agricultural productivity. Among those I knew and respected, there was an obvious quest

[1] Personal communication from Dr. A. P. Appleby, Professor Emeritus of Crop Science, Oregon State Univ., Corvallis, OR.

for the development and use of herbicides in agriculture. There was no compelling reason even to consider the possible disadvantages of herbicides or other pesticides and those who mentioned such thoughts were dismissed as Luddites or environmentalists who did not understand agriculture and its needs.

Research on pesticide use in agriculture, that is applied research, went forward for the usual reasons noted by Reiss (2001). Scientists then as they do now regarded themselves as autonomous with respect to their scientific work. That is not to say that scientists were or are absolutely free to do whatever they want to do. The pursuit of science is constrained by required foundational knowledge (e.g., no work on genetically modified organisms was done in the 1950s because the foundational knowledge was lacking) and by the availability of funds, equipment, and help. However, when research begins, most scientists feel quite free of constraints in the conduct of their work. They are doing what they want to do in a way they decide it is best to do the work. Scientists also believe that what they are doing is interesting (at least to them) and perhaps it has not been done before or has not been done in quite the same way. In the 1950s, herbicides were new and development of new chemical families and modes of action was rapid. Pesticide research was one of the many bandwagons on the highway to increased yields and profit for agriculture. Agricultural researchers saw pesticide research as interesting and the right thing to do. It was an easy way to obtain funding and gain publishable results in the right journals. Publication and funding were and remain important drivers for scientists. Pesticide research also had the glamour of the new. The results were often nearly magical and those who developed the technology to achieve improved, safe, cheap, pest control first, received the adulation of peers and farmers.

Another important reason many agricultural scientists studied the practical application of pesticides is that the knowledge gained was rapidly adopted by farmers. The clear utilitarian argument is that such research ought to be done because it is highly likely to increase the total amount of human happiness and reduce human suffering. Weeding is an arduous, undesirable task. If it can be done with simple application of what was thought to be a safe, highly efficacious, selective chemical, then agricultural scientists have a clear moral obligation to pursue the work to make it possible. In short, agricultural scientists ought to do whatever increases the sum total of human happiness (Reiss, 2001). Reducing the burden of weeding or management of other pests with pesticides was and remains, in the minds of agricultural scientists, an unquestionably good thing.

Although there were a few voices that questioned the wisdom of widespread pesticide use in agriculture, the agricultural community stoutly rejected arguments against pesticide development. As Reiss (2001) points out, the reason was "the standard liberal one that one needs strong arguments before banning things." Banning or restricting the development or deployment of new technology should only be done in the face of completely compelling evidence of harm. The most compelling evidence would be harm to people. Pesticides were a technology that

promised to reduce labor requirements, increase crop yield by reducing weed competition (herbicides) not be harmful to people, and increase profit to farmers. The case for going forward was compelling.

The case against pesticide development was largely absent in the 1950s and for several years after, as the chemicalization of agriculture proceeded. Reiss (2001) offered four reasons commonly used to argue that a particular research project should not proceed. The first, that it would be wrong to even want to do the research, does not apply to agricultural research. The example Reiss (2001) uses is research designed to develop ways of more effectively torturing people. That would be morally reprehensible and nearly all members of civilized societies would consider it wrong even though reasonable arguments can be constructed to support such research. For example, if a person knows the location and time of detonation of a hidden bomb that will kill thousands of people, one could argue that it is permissable to use any means, including torture, to prevent the death of thousands. Harm to one pales in comparison to possible harm to many. It is an argument that has been used to justify radical methods to counter the current terrorist threat.

There is universal condemnation of the WWII Nazi regimes research to develop effective ways of killing people with deadly gas. One must assume there would be universal condemnation of research by weed scientists to develop ways to destroy another nation's crops through application of herbicides. Unfortunately, this has been done (Agent blue = cacodylic acid was used for defoliation and to kill rice in Vietnam) but the knowledge that made it possible was already available from what was known about the action of the herbicide. There was no research project to develop herbicides for the purpose of killing rice. However, the moral justification for using herbicides to destroy crops in wartime (winning the war is the highest value) is weak, at best, and perhaps absent (it is always morally wrong to harm non-combatants, although it is common).

The second reason Reiss (2001) offers is that the process of the research would have undesirable consequences. Those doing the research could be harmed physically from toxic effects or psychologically. Direct physical harm is possible in medicine, microbiology, chemistry, etc. It is also avoidable by proper isolation and protective clothing. Psychological harm may be more subtle and less easily observed but no less real in its effects. One can imagine a case where someone engaged in the development of herbicides for biological warfare (destroying crops) could be deeply disturbed by the moral implications of the work. Fortunately, as far as we know, this kind of work is not being conducted and it seems reasonable to assume that agricultural research may not lead to such clear moral dilemmas.

If the net consequences of research lead to harm, one may question the justification for the research (Reiss, 2001). This, the third, argument is common among those opposed to pursuit of genetic modification in agriculture. The potential for ecological and human harm is real, therefore the research should

not proceed until these potentials have been explored and eliminated. It is hard to understand how such things can be explored if the research on genetic modification is stopped but the argument is common. Presumably researchers will recognize undesirable consequences before they occur. That is one of the purposes of research, albeit one that may be overlooked if the primary purpose is to create and use the new technology rather than to examine its consequences dispassionately.

Reiss also suggests that in a time when research funds are limited one can claim that some research (usually someone else's) should not be done. The research may have merit but with limited funds its merit is less than other work that must be done. This is not immediately a moral argument. It is, or at least it can begin as, a debate about the need for research project A as opposed to project B. Need can be justified economically, politically, or socially. However, supporting each of these arguments one can always discover a moral foundation. Agricultural researchers justify their work with a frequent moral argument that goes like this.

Premise: Food is necessary for human survival.
Premise: Agricultural research leads to greater food availability.
Conclusion: Because agricultural research assures human survival, it ought to continue.

The validity of this argument is unquestioned in the agricultural scientific community. Other research communities make similar claims and decisions on research funding that undoubtedly reflect the values (the moral judgments) of those who make them.

Reiss' final argument concerns possible undesirable consequences of research. It is compelling in the case of herbicides. The cited advantages of herbicides include: low cost, safety, high efficacy, labor saving, selectivity (weeds killed and crops not affected), persistence (weed control over time), energy efficiency, profitable to growers, and increased crop yield. Each of these was and is regarded as a good thing. It was only with the passage of time that questions were raised about each of these presumed advantages. None is a clear advantage because each can also be framed as a disadvantage. For example, herbicides clearly have toxicity to humans and non-target species. Labor is saved but that is not always good when labor is abundant as it frequently is in developing countries. Persistence is good for weed control over time but may lead to undesirable soil residue, injury to a succeeding crop, harm to non-target species, and movement from the site of application. Weed scientists learned that valid counter arguments could be made for every claimed advantage. Undesirable consequences were not only possible, they were common. There is harm to non-target species, residues are present in soil and water, the cost of weed control to users is often decreased but environmental costs are commonly externalized. Advantages, while real, were nearly always short-term for the benefit of this year's crop and this year's profit.

Disadvantages, nearly always, reflected a long-term view. They tend to shift focus from short-term self-interest to long-term general welfare. A long-term view demands a planning horizon an order of magnitude beyond the next election or a 2-year research project. It also demands questioning the dominant view that whatever problems technology creates will be solved by new technology (Peterson, 1978).

CHALLENGES

Challenges to the presumed advantages of agricultural technology and its uses and the quest for a long-term view began with Rachel Carson's Silent Spring (1962) and have continued. Agricultural scientists, most especially those in pest management, were in the words of van den Bosch (1989):

> "Sucked in to the vortex, and for a couple of decades became so engrossed in developing, producing, and assessing the new pesticides that they forgot that pest control is essentially an ecological matter. Thus, virtually an entire generation of researchers and teachers came to equate pest management with chemical control."

The ecological nature of pest control was affirmed by Julian Huxley in his preface to Silent Spring (1962) and is now a consistent, but perhaps not the dominant, theme of weed science research.

For decades, agricultural scientists have been and largely remain technological optimists: technology will solve the problems it creates. Weed science began with the development of herbicides, in an era of forward-looking scientific optimism. The journal Weed Science first appeared in 1951 and the Weed Science Society of America was founded in December 1954 in Fargo, ND. The society's first meeting was in New York City in January 1956. The magic of herbicides appeared to be able to solve one of humankind's oldest problems—how to reduce or eliminate weed competition in crops and reduce the need for human labor to weed those crops. Early weed scientists felt that they were on the cusp of a marvelous new agricultural revolution and the burden of weeding, the arduous labor of the hoe, might disappear from earth. There was no pause to consider lessons from the history of science that reveal how early claims of spectacular advances in human welfare and benefits have, with time, been shown to demonstrate unexpected and highly negative consequences (Parliamentary Commission, 2001). Agricultural education emphasized chemistry and physiology while ignoring questions raised by the history of science and by philosophy.

A report of the New Zealand Parliamentary Commission (2001) examines a wide range of scientific disciplines and technological achievements. It discusses examples from the past century about transportation, chemicals and materials, energy systems, military initiatives, medicine, and ecology. Agricultural examples

include antibiotic use, pesticides, prions, and the social costs of the green revolution. The report shows that "early claims of benefits are dangerously devoid of an adequate understanding of the underlying mechanisms." Agricultural scientists acted and continue to act like all proponents of new technologies in that they are slow to respond to criticism and quick to raise defensive arguments when negative surprises emerge or are suggested. Science was used to reinforce defense of agricultural research. Science was used to counter objections to its results rather than to explore or enlighten the debate (Kirschenmann, 2005). This inevitably weakened public trust in science and scientists. The New Zealand report advocates "the need to recognize the limits to scientific knowledge and the need to adopt a broader integrative approach to managing complexity, one that allows for surprises and values ethical considerations."

Tenner (1996) raises similar issues for those who see only benefit in scientific progress. As reported by Dibbell (1996) Tenner posits that "every technological endeavor is riddled with 'solutions' that backfire." Several negative consequences of agricultural endeavors are pointed out. The dust bowls of the "dirty thirties" and the "filthy fifties" are clear agricultural failures that could have been prevented. Tenner mentions the promotion of pests, which was documented by van den Bosch (1989) who reported the development of pest resistance from repeated pesticide use and the creation of new pests after repeated pesticide use. When pesticide resistance first appeared among insects, weed scientists argued that it was a phenomenon that would be restricted to insects. The basis of the claim was that insects have short life cycles and weeds are annuals or perennials and therefore, if resistance appeared it would take a long time to do so. The reasoning was wrong; 292 weed biotypes representing 174 species (104 dicots and 70 monocots) are now resistant to herbicides from 18 mode-of-action groups, in more than 270,000 fields (Heap, 2003). Herbicide resistance was first discovered in 1968 (Ryan, 1970) and is now known in all classes of herbicides. It is accepted and research proceeds to maintain use while minimizing the inevitable expression of resistance.

The invasion of animal and plant pest species into new areas is incompletely understood. Scientists don't understand why some species succeed and others fail. Among invasive plants, those that succeed are prolific seed producers or asexual propagators, that have escaped natural enemies, disperse easily and widely, and are good competitors, especially in habitats disturbed by humans. The aggressive annual weed, kudzu [*Pueraria lobata* (Willd.) Ohwi] once promoted by the U.S. Department of Agriculture for soil erosion control, is an excellent agricultural example of a surprise, an unintended consequence.

In contrast to much of the environmental defense literature that objects to many technological innovations, Wildavsky (1979) suggests that being too cautious about technological developments may paralyze scientific endeavor and make society less safe. He suggests that "Chicken Little is alive and well in the richest, longest lived, best-protected, most resourceful civilization, with the

highest degree of insight into its own technology" that has ever existed. In the past, society relied on expert opinion to determine what was right and what ought to be done. Now experts disagree about what the data mean and on what data count and the public is left to decide without really understanding the issues. Wildavsky (1997) covers a wide range of topics (acid rain, ozone depletion, global warming, 2,4,5-T (Agent Orange and dioxin), asbestos, saccharin, and others). He uses these to illustrate that the uses and abuses of science are widespread and anti-science bias is pervasive in the public mind. Many of the same issues were mentioned in the report of the New Zealand Parliamentary Commission (2001) with the same beginning assumption that surprise is inevitable in scientific endeavors but the opposite conclusion: caution is always appropriate.

Wildavsky asks if such claims about science and technology are true and if more caution is required or if the demand for caution impedes scientific progress? His answer in all the cases he examined, other than ozone depletion from use of chlorofluorocarbons (CFCs), is No! Nearly all claims about harm are not true; the technology is not harmful. The CFC example is worthy of special notice because the scientific community was sure that these simple, inert chemical compounds could not cause any environmental harm. Many of the examples Wildavsky (1997) examined were also included in the New Zealand report (2001) and it is significant that the two reports reach opposite conclusions.

Wildavsky's Chapter 3 (1997, 45 pages) titled "Dioxin, Agent Orange, and Times Beach," describes the dioxin, 2,4,5-T story in detail. He concludes that *2,3,7,8*-tetrachlorodibenzo-p-dioxin (TCDD) is the one dioxin, among many, that has serious human health effects. It was found as a contaminant in trichlorophenoxy acetic acid products such as 2,4,5-T but was never found, for clear chemical reasons, in dichlorophenoxy acetic acid products, such as 2,4-D. These are chemical facts. Wildavsky (1997) reports that such facts paled in comparison to the political and non-scientific debates that swirled around the dioxin issue. Millions of dollars were spent to discover that dioxin has serious human health effects, but only at extremely high doses, and these occur only with unprotected, prolonged occupational exposure. There is a threshold: "below a certain level, little or no harm would occur; thus some body level might be harmless." The U.S. government and the chemical industry paid millions of dollars to people who were not injured and equal amounts to regulate inconsequential exposures. Wildavsky (1997) concludes the discussion, as he concluded so many others in the book, with the question "Why expend so many resources in the name of public health with so little to show for it?"

The dioxin story is used by Wildavsky as one among many to illustrate that our society has become one that assumes most chemical substances and new technologies are dangerous and only a few can even be used safely. He proposes that it is culturally significant that we fear what is not harmful and therefore, by refusing risk we encourage danger. When everything chemical is regarded as potentially or actually dangerous, society risks losing the advantages that new

technologies may offer. Society may prize safety so much that risk is minimized (Wildavsky, 1979).

Wildavsky (1997) concludes by objecting to the dominance of the precautionary principle in technological decisions. He suggests the precautionary principle should be rejected because "there are no health benefits from regulation of small, intermittent exposures to chemicals." The concluding section of the book suggests an outline for what Wildavsky calls the "case for modern technology endangering humans—the environmentalist paradigm." The outline includes the following points:

1. Possibility should replace probability as a criterion for regulation to protect human health and safety. The mode of risk assessment that increases prediction of harm by the largest amount should be adopted in the absence of proof to the contrary.
2. No cause, however weak, is incapable of producing substantial harmful effects. That is any chemical that causes effects at high doses can be assumed to be harmful at exceedingly low doses. In short—dose does not make the poison, exposure does.
3. The purpose of risk regulation is to prevent health detriments, not to secure health benefits.
4. What is not explicitly permitted is forbidden; substances or processes must be demonstrated to be benign before they can be used. The burden of proof rests on a conclusive demonstration that a substance or a process does not cause cancer or other unspecified harm.

Wildavsky's (1997) optimistic view of technology is based on extensive research to ask if claims against technology are true and he concludes that most claims have not been true. His work stands in sharp contrast to the majority of environmental literature and to the report of the New Zealand Parliamentary Commission (2001) that strongly recommends that society should "interpret evidence in a precautionary framework that seeks to minimize false judgments that no hazard exists when in fact one does." This recommendation values the precautionary principle and does not want to abandon or modify it as Wildavsky (1997) does. Scientific testing "can only deal with the scientifically tractable problem of known uncertainties." When there is scientific ignorance or when science asks the wrong questions or studies the wrong problem, the importance of the unknowns will remain. The dilemma within science is stated well by Holling (1998) who contrasts what he calls analytical science or the science of parts with integrative science or the science of integration of parts. The first is characterized by molecular biology and genetic engineering, which promise to give us health and economic benefits but whose progress is plagued by changing social values. Analytical science is "essentially experimental, reductionist, and disciplinary in character" (Holling, 1998). Integrative science, represented by evolutionary biology and ecology, deals with resource and environmental

management where uncertainty and surprises are expected. In Holling's (1998) view the latter is interdisciplinary and combines historical, comparative, and experimental approaches at scales appropriate to the issues to be addressed. Integrative science relates well to social sciences and is the bridge between analytical science and public policy. Analytical science is reductionistic and certain, while the other is integrative and uncertain. Holling (1998) claims that analytical science can be trapped by providing precise answers to the wrong question while integrative science runs the risk of providing useless answers to the right questions.

Wildavsky (1979, 1997) thinks properly conducted, analytical science can and will answer the important human health questions about any technology. Scientific rigor and the demands of intellectual honesty are presumed to be adequate to answer all important questions. In contrast, the New Zealand report (2001) notes that scientific inquiry too often omits integrative and ethical questions precisely because the latter are not scientific and are often regarded as emotional and value laden, which, of course, they may be. This accusation does not mean that such questions are not important or lack substantive content. The ethical realm asks, by definition, different but no less important questions, which analytical science, by definition, is not prepared or designed to answer and which integrative science approaches but may not answer completely.

Disaster is not the inevitable consequence of either kind of good science and the resulting technological innovations. If one views science and technology over the last hundred years, it is clear the optimists have had it right (Tenner, 1996). There is a plethora of examples that illustrate how analytical science and technology in agriculture have improved food production and human health and made life better. Disasters have occurred but they "mobilize the kind of human ingenuity that technological optimists believe exists in unlimited supply" (Tenner, 1996). Technological disasters will continue to occur and agriculture will cause some, but, on balance, because of analytical science, life will continue to improve for most people. The balance between protecting public safety and the risk of new technologies often takes subtle form. Pesticide residues in or on fruits and vegetables may, it is argued, be harmful to the health of those who consume them, especially children. If we develop a system or a new technology that reduces or eliminates such residues it will be good, except that the poor may consume less fruit and vegetables because the requirements of a system to reduce pesticide residues on them make them too expensive.

Ordinary citizens do not know what to do or who to believe and tend to ignore both the cranks who speak of gloom and doom and think everything leads to disaster of some kind and the optimists who speak of boom and zoom to ever higher levels of technological achievement and human happiness, while acknowledging the possibility of greater disasters in the future. We must acknowledge that our ability to envision the good or the bad is surprisingly limited (Tenner, 1996) and science, unhelpfully, gives us only ranges of probability, not certainty. Because science cannot prove that things (life) will get worse or better,

ordinary folks tend to adopt the Schlitz (a Milwaukee beer) philosophy: "You only go around once, so grab all the gusto you can."

THE CONTINUING DEBATE

HIGHLIGHT 3.1 (Clayton, 2005)

"When R. Given Harper set out to understand why North America's migratory birds were declining, he set a unique course. While other researchers zeroed in on habitat loss as the key problem, he decided to look at an old culprit—the pesticide DDT—and its specific effects on songbirds."

"The effects were intriguing. Traces of DDT and other related chemicals were showing up in the birds." But the real shock came when Harper compared his results with DDT levels in non-migrating songbirds. These year-round residents of North America—including the northern cardinal, black capped chickadee and dark eyed junco—had more kinds of chemicals and dramatically higher levels of them than the migrating species.

Agricultural people know that DDT has not been used in the US for several decades. Residues are present but declining. The abandonment of chlorinated hydrocarbons was fought by most agricultural people but is now regarded as a difficult but good decision. The problems associated with their use (long environmental persistence, lipid solubility, harm to non-target species, bioconcentration) have been recognized. The more important lesson is that we must always be careful with what is put in to the environment because many things are not easily, and may be impossible, to retrieve. All effects are not known (cannot be known) at first use.

The possibility of disruption of endocrine function (Colburn et al. 1996) was not even considered when the chlorinated hydrocarbons were used. Now the phenomenon is known but many regard it as a remote possibility because, in their view, dose alone determines the poison and environmental doses are very low. But that is the point. Low doses act as endocrine disruptors when they are present at certain stages of embryo development.

The arguments between the technological optimists (those who some call Cornucopians) and the pessimists (the Cassandras or Jeremiads[2]) will continue. Final resolution is not highly likely because technology advances and the issues to argue about change, and, therefore the nature of the argument changes. The

[2] I set watchmen over you, saying, Hearken to the sound of the trumpet. But they said, We will not hearken. Jeremiah 6:17.

advent of agricultural biotechnology has altered the debate. Questions about agricultural technology used to focus on three questions:

1. Did the new technology work better than the old one? Was it more efficacious?
2. Was the new technology safer for users?
3. Was the new technology better than its predecessor? Better could mean it was more efficacious, cheaper, or safer.

Biotechnology has introduced a new question—Do we need it? The question might also be framed as, Ought we to do it? Thus, it becomes a moral rather than just a scientific or economic question. The results of analysis of the production and social effects of agricultural technology are not all negative (see Wildavsky, 1997); much of it has been needed. The world now feeds more people an adequate diet than ever before. There are still too many hungry people but if we relied on past production methods we could not feed all that are now fed. It is correct to affirm that agricultural technology has been of great benefit. It is also correct to recognize that the technology has caused great problems.

A 1994 CAST report (Waggoner, 1994) claimed, with supporting analysis, that by harvesting more per unit area through the use of modern and improving agricultural technology, farmers could feed a future population of ten billion humans *and* spare land for nature. If farmers did not or could not take advantage of improving technology more land would be required to produce food and fiber. Farmers and the agricultural technology they use to produce food and fiber could be (should be) "at the hub of sparing land for nature." Waggoner's report is an optimistic appraisal of the value of agricultural technology.

Avery has shown, with careful analysis, that modern agricultural technology has saved thousands of acres that would have been required to produce today's yields with 1950s technology (Avery, 1994). He claims (1997) that modern agricultural technology, especially crop protection technology is "one of mankind's greatest environmental achievements." The land not required for production can be used for wildlife, urban development, or left alone because it is not needed to produce food and fiber. Because agriculture is the most widespread and most significant human interaction with the environment, only by reducing agriculture's need for land, can land be saved for nature. The biggest danger to wildlife and by implication to the environment is the potential conversion to agriculture of land that is now in tropical rain forests so the land can be used to produce low yields of crops and livestock. In Avery's (1994) view, to eliminate world hunger quickly, society will have to do two things with far more effort than has been devoted to them to date. First, more investment will have to be made in high-yield farming technology for the third world. It is Avery's (1994) view that the necessary investments have not been made because what he calls eco-activists have successfully crusaded against the "high-yield seeds, the fertilizers, and the pesticides that will need to be part of the high-yield packages." Avery (1994,

1997), Waggoner (1994), and Wildavsky (1997) agree on this point. Second, there must be a simultaneous upgrading of "the skills of third-world workers to instill the necessary concern for honesty and human rights in the governments of third-world countries. Avery claims that world hunger can be eliminated by those things that increase production—technology and human skill.

Sen (1976, 1999), in contrast, does not diminish the importance of production but emphasizes that virtually all of the world's famines since World War II have been due to governmental mistakes or wars. That is famines are caused by political action that inhibits production or political action to withhold food, not by farmer's failures to produce or, by implication, the lack of sufficient production technology. Food security and access to food are often more important than food supply (Sen 1976). In Sen's (1999) view, undernourishment, starvation, and famine are influenced by the working of the entire economy—not just food production and agricultural activities as Avery (1994) claims.

Conway (1997, p. 33) agrees with Avery's (1994) view but differs in his view of what must be done. Conway argues that it will be possible for the world to provide enough food for everyone if (the important word) we (not just the U.S. but all countries):

—Increase food production at a greater rate than in recent years;
—Do this in a sustainable manner, without significantly damaging the environment; and
—Ensure the food produced is accessible to all.

The latter is, of course the hardest part. Conway's (1997, p. 134) is a more nuanced analysis of the problems of feeding the third world than Avery's (1994). He establishes five priorities to achieve the goal of feeding all:

—Higher yield per hectare;
—Produced at less cost;
—With less environmental damage;
—Creating employment and income opportunities for the landless; coupled with
—Pricing, marketing and distribution policies that ensure that the poor gain.

Conway (1997, p. 86) recognizes that the green revolution of the 1960s was dominated by the strongly held view that "a healthy, productive agriculture would necessarily benefit the environment. Good agronomy was good environmental management." Avery (1994, 1997) concedes this dominant view and thinks it is the correct view. Agricultural scientists have believed the same thing—good agricultural science is automatically good environmental management.

The technological optimists (the Cornucopians) who have read this far will tend to agree with the appraisals of agricultural technology offered by Avery (1994, 1997) and Wildavsky (1979, 1997). The more cautious will tend to agree with Tenner (1996) and the New Zealand Parliamentary Commission (2001) that surprises are an inevitable concomitant of analytical science and caution,

therefore, is obligatory. Many other sources of conflicting views can be found and could have been included in this chapter, but have not been because the list becomes long and greater clarity does not follow from additional sources. In addition to Avery and Wildavsky, the Cornucopians include Julian Simon, Herman Kahn, and The Heritage Foundation, the Hudson Institute, the Competitive Enterprise Institute, and the Washington Legal Foundation. Among the Jeremiads one will find Paul Ehrlich, Lester Brown, Wendell Berry, Wes Jackson, the Audubon Society, the Sierra Club, and Greenpeace Int. Most people are left in a quandary by the confusing information from the polar views. If they choose to try to work their way out they may become convinced by the rhetoric from one side, or just stop thinking about the issues as their quandary deepens.

The reminder of this book will try to demonstrate that underlying each set of views on important societal and agricultural issues is an ethical position that is often unexamined and may even be unknown by its possessors, until it is identified and examined. Knowing the ethical foundation for any position on an issue is, I suggest, an important step toward resolving the issue. The issue to be resolved is not Wildavsky's (1997) question of whether or not accusations against technology are true but the more fundamental ethical question—What ought to be done? What is the right thing to do? The answer to the question about agricultural or any other technology will not be found in science, although science is essential to the quest. Science tells us what it is possible to do. When one knows what is possible, it is neither the data nor the conclusions that are most important but the reasons one chooses and can support with clear arguments that determine what ought to be done.

In his discussion of the promise and problems of technology, Peterson (1978) concludes with a parable to illustrate the importance of being able to make the proper judgments in any human dilemma. To make the proper judgment one must be aware of and examine the reasons that support the judgment. If the reasons for an action are not made explicit, one risks making a decision based solely on economic, social, or political criteria and while it is appropriate to consider these factors, they alone are not sufficient for the best decision.

Peterson (1978) notes the parable was invented or translated by the English author, Somerset Maugham and was used by John O'Hara as the title of his first novel—Appointment in Samarra.

> The chief steward of a wealthy merchant in ancient Basra went into the marketplace one day, and there he encountered Death, dressed as an old woman. On seeing the steward, Death suddenly drew back. In great terror, the steward returned immediately to the merchant's house and said, "Master, today I saw Death in the marketplace, and she made a menacing gesture to me. Please let me ride to Samarra, so that I can escape." The merchant replied, "By all means, take my fastest horse and ride."
>
> Later the same day, the merchant himself went into the marketplace and he, too, saw the old woman. He stopped her and said, "My servant told me that he

met you here this morning and that you threatened him." And Death replied, "Oh, no—I did not threaten him. I was surprised to see him here in Basra, because tonight I have an appointment with him in Samarra."

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CHAPTER 4

An Introduction to Ethics

"Some there have been who have made a passage for themselves and their own opinions by pulling down and demolishing former ones; and yet all their stir has but little advanced the matter, since their aim has been not to extend philosophy and the arts in substance and value, but only to . . . transfer the kingdom of opinion to themselves."

Sir Francis Bacon

Discussion about ethics in agriculture should not be regarded as something that is so scholarly that it risks being unaware of the realities of agriculture or the realities of the ethical life, that is, it should not be regarded as just an academic matter. Ethics is not just an area of academic discourse that is fine in theory but not useful in practice. It is the opposite. An ethical theory that is useless in practice, that is in life, is just that—useless. Ethical theories and the values that undergird them, support our daily life and if an ethical theory is not useful in life there are serious flaws in the theory that purports to supports the practice. Ethical foundations, known or unknown, are used to form the reasons for action; the reasons why we do what we do.

My experience when I have brought ethics into discussion of agricultural issues has been that my colleagues while willing (even eager) to engage in the discussion are not persuaded to continue the quest. Ethics seems to be regarded by agricultural scientists as something that is peripheral to the conduct of their science, rather than central. It is regarded as something that is purely academic. There is no reluctance to begin discussion of the ethics of agriculture but there is a sense that it is unnecessary. Agriculture, after all, deals with producing food and fiber for humankind and, the general view is that, the practice of agriculture is *a priori* ethical. Agricultural scientists, indeed most people, think they are and actually are, fundamentally ethical in their daily lives. If moral energy must be expended it most commonly goes toward defending claims against us, and "that includes protecting the state of our soul as purely private, purely our own business" (Blackburn, 2001, p. 4).

If Blackburn (2001) is correct that the majority of ethical reflection is purely personal and if agricultural practice is already ethical (agriculture feeds people), what is the problem? The problem is that this claim ignores several problems including the environmental problems the practice of agriculture has created: soil erosion, pesticide pollution of soil and water, pesticide harm to human health, pesticide harm to non-target species, fertilizer (especially nitrogen), pollution of water, human displacement by labor-saving technology, etc. (see Aiken, 1984). The claim that agriculture is ethically correct ignores the charge, previously cited, that modern technology that permits one person to do the work of a thousand also permits that person to wreak the environmental havoc of a thousand (Peterson, 1978). Environmental and other problems caused by agriculture have largely been externalized, thus transferring the effects and costs of agriculture to the general society. Agriculture's practitioners thereby avoid ethical challenges. The claim also ignores key ethical questions—What ought to be done? What is the right thing to do? The position ignores the core of morality: "When moral worth is at issue, what counts is not actions, which one sees, but those inner principles of action that one does not see" (Blackburn, 2001). An ethic is a moral theory that has been developed by careful thought and is consonant with inner moral principles and available scientific knowledge (Comstock, 1995). Agriculture has largely ignored the necessity of formulating an ethic which defines and enables defense of its moral foundation.

The apparent reluctance of agricultural scientists to raise and resolve ethical issues arises partially from the unexamined assumption that their activity (their science and the practice of agriculture) is already ethically correct. Agricultural people have not needed an ethicist to point out that their ethical responsibility was production of healthy, nutritious, abundant food (Dundon, 2003). They know they have done this well. The apparent reluctance also arises from at least three other sources. The first is the fact that people engaged in agriculture (farmers, ranchers, and scientists) have not been educated to question agricultural practice. Agricultural education does not emphasize and often completely ignores the moral aspects of the problems agricultural practice creates. Consequently, students and those who practice agriculture do not have the linguistic or intellectual tools to discuss the ethics of agricultural practice and are not encouraged to do so. Agricultural education emphasizes study of how to employ technology to increase production and profit. It does not emphasize questioning the technology or its results. Secondly, there is a pervasive idea that ethics is largely, if not completely, subjective. Ethical decisions, it is claimed, are just a matter of opinion and opinions are strongly influenced by one's culture. There are no ethical facts available to support one opinion as opposed to another. Thus, there is no factual basis to question or defend an ethical position. The claim is that no one can prove their ethical view is the correct view. Ethical claims are not the kind of rational truth referred to in Chapter 1. They do not consist of rational statements defined mathematically, which are publicly verifiable, literal, definitive, and

precise. Opinions are just personal views and lack objective truth. Ethical views, from this perspective, are just one opinion against another. Finally, McKibben (2003, p. 186, citing Rothman 1998, p. 37) points out that when scientists do deal with a moral question, "even the language of moral inquiry quickly turns technical." Acting immorally is translated as "acting without knowing the consequences, taking risks." Playing God, an expression from the realm of personal knowledge, is vague but becomes understandable, in the scientific mind, when it is translated as acting without knowing the consequences (Rothman, 1998). Reducing moral questions to consequentialist objections makes such questions manageable for scientists. The objection to the technology is reduced to the technical problem of how to reduce risk from the technology, the solution to which is a scientific, quantifiable matter (Sandler, 2004).

SCIENCE AND EMOTION

Modern agriculture is based on science, which presents a defensible, objective tale of "what is" and "how things work." Agriculture's productive success has been achieved by the careful application of science and technology, largely without reference to what is regarded as the subjective, emotive story of what ought to be. However, emotions actually produce quite reasonable human behavior, especially from the point of view of survival (Damasio, 1999, p. 54). Human emotions are frequently inseparable from the ideas of reward or punishment, pleasure or pain, approach or withdrawal, and of personal advantage and disadvantage. Inevitably emotions are inseparable from the idea of good and evil (Damasio, 1999, p. 55). Nevertheless, neither philosophy nor science has trusted emotion, and science, especially, has dismissed emotion as unworthy of trust. Damasio (1999, p. 38) reports that Darwin, William James, and Freud all wrote extensively on different aspects of emotion and "gave it a privileged place in scientific discourse." But emotion has not been trusted in scientific inquiry or in the laboratory. Emotions are too subjective, elusive, and vague (Damasio, 1999, p. 39). Emotions are "at the opposite end from reason, easily the finest human ability and reason, scientists assume, is presumed to be entirely independent from emotion" (Damasio, 1999, p. 39). Thought about emotion places its origin in the brain where reason also occurs, but relegates it to a lower neural status. Emotion was not rational and even studying it was probably not rational (Damasio, 1999, p. 39). Singer (2000, p. 14) tells us that "If emotion without reason is blind, then reason without emotion is impotent." Both are required in all fields of human endeavor, including, or perhaps one should say, especially, agriculture.

However, these twentieth century assumptions about the exclusively emotional basis of values and ethics and therefore what ethics is about are unwarranted and not defensible. Both science and ethics are highly value-laden and full of emotion.

Emotion is involved in determining what a scientist chooses to study. Scientists may become irritable, excited, demanding, and maybe even irrational when debating the importance of an experimental approach or the interpretation or value of results. Values are those things we humans hold most dear. They are matters which demand enthusiastic participation (science, skiing, music), or things toward which we feel most compassionate (children, the homeless, stray animals, small business people), or they are foundational to beliefs which cause us to behave in certain ways (scientific objectivity, religion, political affiliation) and accept some propositions wholeheartedly (no new taxes) while rejecting others (foreign aid) (Shahn, 1957, p. 95). If we attempt to exclude emotion from judgment, value may consist only of those things which one holds to be most important (national defense, preservation of national parks, feeding the poor) (Shahn, 1957). Our values are how we define what is most important—they are how we put first things first. Be it ever so logical, the process is not without its emotional aspects (Shahn, 1957, p. 95). In fact, the more important a matter becomes in all fields of human endeavor, the more emotionally laden it becomes. Because scientists learn that science does not make value judgments, they have a passion for objectivity, a value of the highest order. Important scientific matters should be decided objectively with the facts not with subjective, emotionally-laden opinions. As scientists use and rely on objective criteria they risk failing to recognize where the objective intellect leaves off and emotion begins.

UNIVERSAL VALUES

Given the common assumption that values and ethical decisions are all subjective and culturally influenced, it is logical to posit that there cannot be any universal values shared by all humans that extend across cultures and time. Kidder (1994) however, proposed an "underlying moral presence shared by all humanity" that erases borders, races, and cultural traditions. These may be the values one might teach students or hope that children learn as being universal; they are the right things to do and ways to behave. The elements of a universal code of ethics, universal values, identified by Kidder (1994) after interviews with 26 individuals from 16 nations include:

Love	—love of all people, compassion, helping one another,
Truthfulness	—keeping promises, not lying or being deceitful,
Fairness	—fair play, justice for all, the pursuit of equality,
Freedom	—the desire for liberty, political democracy,
Unity	—the need for community, solidarity, cooperation,
Tolerance	—acceptance of thinking differently, listening to different views,
Responsibility	—for actions, for the future, for others
Respect for life	—do not kill.

Josephson (1989) expresses the values above in slightly different words. Things that are right are the things that help people and society. In his view they include compassion, honesty, fairness, and accountability, which he regards as absolute universal values. For Josephson, the essence of ethics is some level of caring. Blackburn (2001, p. 127) cites things that virtually all human beings care about for themselves: safety, security of possession, satisfaction of basic human needs, and a basis for self-respect.

> "Every society that is recognizably human will need an institution of property (some distinction between 'mine' and 'yours'), some norm governing truth-telling, some conception of promise-giving, some standards restraining violence and killing. It will need some devices for regulating sexual expression, some sense of what is appropriate by way of treating strangers, or minorities, or children, or the aged, or the handicapped. It will need some sense of how to distribute resources, and how to treat those who have none. In other words across the whole spectrum of life, it will need some sense of what is expected and what is out of line."
>
> (Blackburn 2001, pp. 22–23)

Societies also have other similarities that relate to their ethical foundation. Virtually every culture has its version of the Cinderella story and some version of the Golden Rule[1] is found in all religions (Van Eenwyk, 1997).

Many will immediately note that each of the sets of good values noted above is violated regularly by individuals and nations. Therefore, one must ask, how can they be universal? One can only agree that each is violated regularly but one must also recognize that humans in most societies lament and note violations as failures not achievements. Tharoor (1999) addresses the same issue and arrives at the same conclusion: there are universal human values. There is objective truth in ethics in that humans, independent of race, nation, or culture, can agree on some standards as being right. Things that are right not just for me or you, or just for today, but for all people in all places always. Tharoor (1999) notes the philosophical objection that nothing can be universal because all rights and values are limited by culture. Because there is no universal culture, there can be no universal human rights. Of course, Tharoor is correct; there is no universal culture but the "number of philosophical common denominators between different cultures and political traditions make universalism anything but a distortion of reality" (Tharoor, 1999). Universality does not presuppose uniformity (Tharoor, 1999). Basic human rights, the things on which people across cultures agree, can

[1] *Christianity*—All things whatsoever ye would that men should do to you, do ye even unto them, *Judaism*—Thou shalt love they neighbor as thyself, *Islam*—No one of you is a believer until he loves for his brother what he loves for himself, *Hinduism*—Men gifted with intelligence . . . should always treat others as they themselves wish to be treated, *Taoism*—Regard your neighbor's gain as your own gain, and regard your neighbor's loss as your own loss.

be universalized and should be promoted even though they do not now exist in all nations. These include:

- The right to a normal course of life.
- Freedom from torture.
- The right not to be enslaved, physically assaulted, arbitrarily arrested, imprisoned, or executed.
- The expectation of tolerance of difference.

Again many will note that these rights are regularly denied in many nations. Because this is true, they will ask, how can such rights be regarded as universal? What seems to be universal in this view is not what is good but that some people are bad and some governments deny basic human rights. Gould (1993) wrote of what he called this "vexatious issue of human nature." He begins with a discussion of biological evolution and his introduction concludes with the scientific observation about evolution that "events of great rarity (but with extensive consequences) make history."

Agricultural students are not taught to question the effects of agricultural technology, and they learn, as many students do, that humans, by nature, are greedy, aggressive, and compulsively and selfishly acquisitive. We are natural beasts and nature is really red in tooth and claw. We humans express such natural instincts differently but they define who and what we are. Gould (1993) claims that events of great rarity create what we observe as evolution. His analogous claim is that human events of great rarity make history; "human history is made by warfare, greed, lust for power, hatred, and xenophobia" (Gould, 1993). But then he says, wait a minute, even if such events create our history, it does not follow that the occurrence and nature of these events define human nature. Human nature is defined by what Gould (1993) calls "Ten Thousand Acts of Kindness." We humans do not go about our daily lives hitting or threatening to hit each other. We do not fight daily. We make way for the elderly and the infirm. We hold doors for others (perhaps, if we are old, we hold doors open for women). We say "thank you" and "pardon me." We smile a lot, even at strangers. Gould asserts that we are basically nice folks and our real nature is not defined by the infrequent bad (albeit major) events that determine the fate of nations. We are incorrect in assuming that "the behavioral traits involved in history-making events must define the ordinary properties of human nature." Violent events make the news we hear each day. Violence dominates what we watch on television. Kindness is fragile and easily overlooked because it is so common, but it is what dominates daily life. The universal values identified by Blackburn (2001), Kidder (1994), and Tharoor (1999) are what characterize human life on this planet. Most people ascribe to and practice them. Some of the most basic ethical issues and values are not just opinions that differ between cultures, races, genders, and time; they, indeed, are universal.

A story I use in our agricultural ethics class will affirm, but I hope not overemphasize the point. Early in the semester, I tell the class that only blonde

women will be able to receive a grade of A for the semester. The best men and brunettes or red headed women may achieve is a grade of B. I justify the decision because I am the Professor in charge of the class and it is my responsibility to set the standards by which student performance will be judged. Not surprisingly, over several years and among different students, the reaction is always the same—That is not right! You can't do that! When pressed to explain why it is not right, the students always offer the same reasons. It is not fair! It is not right to award a good grade to blonde women! Being blonde and female has nothing to do with class performance! It is arbitrary! If I maintained my right to establish a blonde/female grading criterion, students would appeal to my department head and to the Dean and they would win the argument.

It is a simple case to illustrate that all ethical questions are not just matters of opinion. There are ethical standards that are not just subjective and, to the student's surprise, there is widespread agreement on many things. Hair color and gender are not appropriate grading criteria. Beating one's girlfriend or wife is not OK. Slavery is not right. All humans should be free of torture and the threat of bodily harm. Moreover, there is widespread agreement on the reasons why some things are right and others are not. Most ethical matters are not just up for grabs; they are not just your opinion versus mine.

ETHICS IN AGRICULTURE

Discussion of foundational ethical principles is essential if agricultural practice is to change in the sense that some of the problems agriculture practice causes are to be reduced or solved and if public challenges to agricultural practice are to diminish. Many professions have a view that they are better than, more ethical, than most others (Josephson, 1989). Each profession tends to see the shortcomings of others and justify moral laxity by saying that what is observed represents aberrant behavior, not the professional standard. For agriculture, ethical lapses are often identified by outsiders who agricultural folk claim don't really understand the essentiality of agriculture and its production technology (Aiken, 1984). Outsiders, it is claimed, demand a higher standard than they practice. Besides, it is argued, some values must be sacrificed (e.g., environmental quality) to higher values (e.g., increasing production) if agriculture is to progress toward fulfilling its primary task: feeding the world. Agricultural people often argue that they are not the only ones guilty of ordering values. They claim—*Tu quo que*—Thou also, or more simply, you do it too. A claim, which, of course, does not absolve one of guilt.

As we explore what ought to be done rather than just what can be done, we will find surprising agreement about the standards by which one decides what ought to be done and why some things are the right things to do. Once one decides between the clearly unethical and the ethical thing to do, there will still be conflicts, there will still be choices. If we can agree that it is usually not

ethically correct to lie, steal, cheat, or harm others then we still have to decide what is the right thing to do to address agriculture's problems. We will face moral dilemmas that do not involve a choice between what is ethical and clearly not ethical but between two alternatives, neither of which is all bad. The result of choosing is often not clear when the choice has to be made. That is why we say we are caught on the horns of a dilemma (di = two, lemma = propositions). Such choices are common human experiences—To be or not to be, whether or not to eat the apple, Sophie's Choice, the lady or the tiger (Van Eenwyk, 1997, p. 31). Moral dilemmas are common in agriculture and we need an ethical foundation to help decide between two choices where each has strong supporting arguments. For example:

1. Should we increase agricultural production, to feed more people, regardless of the environmental harm the technology that creates the production causes?
2. Should we raise animals in confinement if it is harmful to the animals but makes meat cheaper for consumers?
3. Should we mine water from deep aquifers to maintain present irrigated farms in dryland areas even though the production system is not sustainable?
4. Should we change the U.S. soybean production system to decrease soil erosion?
5. Should we decrease nitrogen fertilizer use in the Mississippi basin to reduce the effects on fishing and ecological stability in the Gulf of Mexico?
6. Should family farms be protected and preserved or allowed to die because they are economically inefficient, that is, they can't make sufficient profit?
7. Should we give more food aid to developing countries?
8. Should we accept or reject agricultural biotechnology?
9. Should we reduce herbicide and other pesticide use in American agriculture?

All the things in this partial list are difficult dilemmas for agriculture and each has a moral dimension. It is time, indeed past time, for all involved in agriculture to think about and address these and similar questions. The next generation of agriculture's practitioners, scientists and teachers should be equipped with the intellectual tools that are required to guide decisions about agriculture's existing and future ethical dilemmas (Chrispeels, 2004). Because each of the above questions is fundamentally an ethical question, we now turn to a brief description of a few of the ethical theories that may guide us as we try to address the moral questions that agricultural practice compels us to consider.

CONTEMPORARY NORMATIVE ETHICS

> We are discussing no small matter, but how we ought to live.
>
> Socrates, as reported by Plato in The Republic

Moral philosophy is the branch of learning that deals with the nature of morality and the theories that are used to arrive at decisions about what one ought to do and why. Much has been written about moral philosophy and the theories that support ethical decisions. One of the best, brief explanations of moral theories is found in the work of Rachels (2003).

> "If we want to discover the truth, we must try to let our feelings be guided as much as possible by the arguments that can be given for the opposing views. Morality is, first and foremost, a matter of consulting reason. The morally right thing to do, in any circumstance, is whatever there are the best reasons for doing."
>
> Rachels 2003, p. 12

I will draw heavily on Rachels' work and will briefly present only five moral theories: Ethical egoism, Social contract theory, Virtue theory, Deontological or Kantian ethics, and Utilitarianism. These moral theories are largely unexamined within agriculture but, I submit, may be operative among those who practice agriculture. The chapter will conclude with the one theory (utilitarianism) that seems to dominate resolution of moral dilemmas in agriculture. I will not make any attempt to say all that could be said about morality, moral philosophy, or moral theories. That is not the purpose of this book and others (see the extensive work of Blackburn, Comstock, Rachels, & Singer) have discussed these things well.

A note of caution—the encounter with meaning in ethics often cannot be controlled by the seeker of meaning. The seeker of scientific truth, what I earlier identified as rational truth (Chapter 1), pursues something that can be defined mathematically, and is publicly verifiable, literal, definitive, and precise. In ethics, there are no moral facts that can be raised up and offered to others in the same way. Meaning in ethical discussions, as distinct from scientific truth, comes about as a result of the application of reason in a relationship of openness and trust (Van Eenwyk, 1997, p. 79). The relationship may seem to resemble a chaotic mixing in which both the experiencer and what is experienced become so intertwined that a new symmetry, a new understanding, may come into being. For many this may seem to move too close to the realm of personal truth or subjectivity, which, in science, is the least worthy of being called truth. But in moral philosophy and ethical decision making, the use of human reason to search for meaning, is not just subjective. Invisible, beneath every moral decision, beneath every gut reaction or feeling about what is the right thing to do, there is a moral foundation—a moral theory. To say it is all just subjective is an artifice we use to avoid examining the reasons for our ethical decisions (Marks, 2000, p. 13).

HIGHLIGHT 4.1

Aiken (1998) proposed five proper goals for agriculture. They are:

1. Profitable production.
2. Sustainable production.
3. Environmentally safe production.
4. Satisfaction of human needs.
5. Compatibility with a just social order.

As agriculture's practitioners think about the ordering, comparative desirability, and the difficulty of achieving one or more of these goals, it is inevitable that they will ask, to what extent current methods of agriculture lead us toward or away from a productive, sustainable and environmentally sensitive agricultural system. It is clear that, except for large producers, agriculture is not especially profitable and is becoming less so, even for large producers. Our present system fails to achieve the first goal for many agricultural producers.

Many question if our present capital, energy and chemically dependent, but highly productive agricultural system, is sustainable. If agriculture is viewed purely as a production enterprise and its efficiency or achievement is measured solely in terms of output per acre, per person, or per hour of human labor, then it is efficient. If, however, efficiency is measured in terms of sustained production over an infinitely long time, then our present system may not be sustainable. The second of Aiken's (1998) criteria is not satisfied. Because agriculture is the single, largest human interaction with the environment, it is inevitably disruptive. Ecological stability is a goal to be constantly approached but possibly never reached. That means agriculture should not use production and profit as its only criteria of success. Agriculture should not be just an extractive industry; it must be restorative. Its required technology must complement not harm nature. Farming systems that restore ecological systems are desirable. The proper use of science is not to conquer nature but to live in it. The "ultimate proper goal of farming is not the perfection of crops, but the cultivation and perfection of human beings" (Fukuoka, 1978). Goal three is elusive but achievable.

Agriculture as we know it in the world's developed countries satisfies most human needs and most human wants (e.g., strawberries any month of the year). But do we live by bread alone? Are small, rural communities important, and, if so, are they important only to their residents or do they have value for all? Is the agricultural landscape (those amber fields of grain) valuable? Should a society take pride in the fact that less than 2% of its population feeds 98%, which heralds the decline of rural life and suffering for many who must leave the land. Should satisfaction of human nutritional needs and wants always take precedence over ecological needs? Do our food needs and

wants support an unsustainable agricultural system? Whose responsibility is it to achieve agricultural sustainability? There are many moral questions that those engaged in agriculture ought to be addressing.

Too many people in my town, in my state, in my country, and in our world are regularly hungry and malnourished. That implies that agriculture is not compatible with a just social order and not directed toward achieving justice for all. Achieving a just social order is, by definition, a social, not a production goal. Agriculture has not typically been regarded by its practitioners as a social enterprise. But, all must eat to survive. To eat all must be able to grow their own food, harvest it from nature, steal it, buy it, or be given it. Most humans cannot grow their own or hunt and gather food. Most do not steal. Most buy their food and a few are given food. A just social order has not been an agricultural goal. It is a moral goal where agriculture and society intersect.

ETHICAL THEORIES RELEVANT TO AGRICULTURE

Ethics, in one sense, is a branch of philosophy that studies and examines values relating to the standards of human conduct and moral judgment (Rollin, 1999). In this sense, ethics deals with the basic principles that determine the rightness or wrongness of certain actions and with the goodness or badness of the motives and ends of those actions. In another sense, ethics is a system of moral principles that govern and define how people should (ought to) behave in a particular group or culture (Rollin, 1999) (e.g., Christian ethics, Medical ethics). In this sense, ethical behavior is comprised of the reasons that govern people's views of right and wrong, good and bad, fair and unfair (Rollin, 1999). Underlying and supporting ethical behavior are the ethical theories that describe reasons for choosing a particular action and what it is that makes it moral.

For more details of the arguments below for each moral theory (see Blackburn, 2001; Holmes, 1993; Marks, 2000; or Rachels, 2003).

Ethical Egoism

The central idea of ethical egoism is that all will be right if all people do whatever will best promote their best interests. To be ethical, one must always act to promote one's own good. All acts ought to be self-interested acts.

It is a simple and appealing theory. What could be better than always doing what is good for oneself? Many farmers and ranchers would welcome a moral theory that permits them to do what is best for them and their operation

without regard for anyone else or anything else. Ethical egoism does not say that one should always maximize personal good. That would be egoism and have no ethical component. Those who ascribe to ethical egoism are not necessarily more selfish or egotistical than others may be. If the ethical egoist is asked to cut the birthday cake, the largest piece may go to someone else because, in the long run, that serves the cake cutter's best interest. Therefore, this standard does not mandate that one avoid actions that help others, because the helper may have an ulterior motive of self-interest. Ethical egoism also denies that frequent losses of money in Las Vegas or heavy drinking of alcohol, while momentarily enjoyable, are acceptable, because in the long run, they work against self-interest.

Ethical egoism does not require altruistic acts and may often dictate against them but it does not rule them out, especially when such acts may be perceived to serve one's own interests, in the long run. As Rachels (2003) points out, ethical egoism makes most altruistic acts less than desirable because they tend to de-emphasize the importance of self-interest. Ethical egoism is compatible with common sense morality in that it supports actions that contribute to promotion of one's best interests: do not lie, keep your promises, and do not harm others (Rachels, 2003).

In spite of its appeal and in spite of the fact that many people act as ethical egoists, the theory has serious faults that prevent its adoption as a universal standard. Most importantly, it fails to explain how to resolve conflicts of interest. For example, consider the case where two siblings have inherited a farm on the death of their parents. One considers it to be in her best interest to maintain the property as a farm and become a farmer. The other considers it to be in his best interest to sell the land to a developer and reap large profits. Both are acting in their own best interest and ethical egoism does not offer any way to resolve the conflict of interests (Holmes, 1993; Rachels, 2003). As Holmes (1998) points out, because ethical egoism is a consequentalist position (what happens is what counts), and we know that we cannot always predict the results of an action, we may be wrong and an action may not be in our best interest.

It is also clear, as the farm example shows, that ethical egoism may be logically inconsistent. Both siblings are acting in their best interest and it is wrong to harm another by denying them the ability to act in their best interests. No moral theory can be both right and wrong at once. Finally, Rachels (2003) suggests that ethical egoism is unacceptably arbitrary because it divides the world in two—my interests and the interests of all others. The claim that my interests are always more important than the interests of others just won't hold. It works against common sense. Everyone is interested in eating and we all must. My interest in eating should not always trump the equal interest of someone who is poor but has the same need I do.

Social Contract Theory

Under this theory, the right thing to do is to follow the rules that rational, self-interested people have agreed upon and established for their mutual benefit. Rachels (2003) provides a good explanation of the essence of social contract theory as a moral foundation for a society. The basis was first set forth by the British philosopher, Thomas Hobbes (1588–1679) who posited that all people want to live in a peaceful, cooperative society where all are governed by a set of moral rules that all have agreed to for their mutual benefit. It is an unwritten, but known, contract among those in a society. The idea is that people can freely reach an agreement about the principles that will govern all of them (Holmes, 1993). Because those who make it will be affected by the social contract, it follows that they should be the ones who create it. Rachels (2003) says the idea is feasible because people have an equality of need and there is a scarcity of goods that people want. In addition there is an equality of human power that can be created by the contract. Some are smarter or richer but they cannot and should not prevail forever against others who act together. Finally we cannot rely on the goodwill or altruism of others. All are primarily self-interested and while they may help others in need, it is more likely that they will not, so society needs to be ordered in such a way that the vital interests of all will be served.

Hobbes suggested that because self-interest governs human behavior, all will be doing what they can to get what they need. Scarcity means that many will be competing for the same goods and life will become intolerable in the face of relentless competition of all against all. To escape the inevitable societal collapse when governments collapse and there are laws but no one to enforce them, we create rules that govern behavior and relationships.

Rachels (2003) quotes an unnamed critic of social contract theory—the social contract "isn't worth the paper it's not written on." The problem is that the social contract is an historical fiction. There has never been one and no one has ever signed or been asked to sign one. There is an implicit contract that we all participate in and members of any society become part of (presumed signers) by their action according to the rules of any society (Rachels, 2003). A more important problem with the theory is that it is easy to exclude the poor, the dispossessed, the homeless, and the uneducated. These members of a society may not know the rules intended to govern member's behavior and do not benefit from the social contract.

A modern view of social contract theory is that set forth by Rawls (1971). He proposes a thought experiment centered on the kind of society we want to live in. In this experiment, each person will be acting from what Rawls calls the original position. From this position, each is asked to select the principles that will create a proper society. The society will accomplish what Rawls regards as the essentials of a well-ordered society. It will be a social structure that will

advance the good of its members, be regulated by a public conception of justice that the basic institutions of society satisfy and that the people know they satisfy. Everyone will accept the same principles of justice, and society will be stable (Holmes, 1993). Those who choose the principles are assumed to be rational and self-interested as they select the principles that will govern relations among themselves. Because we are all self-interested, each of us will want to choose principles that favor our position in society, indeed, our position in the world, although Rawls seems to assume all who choose are Americans. Therefore, as decisions about the society are made, each person will operate behind a "veil of ignorance." The veil prevents each person from knowing what position they will occupy in the society. Because of the veil, no one can know, as the contract is being prepared, whether they will be rich or poor, educated or uneducated, male or female (Rawls does not mention gender), healthy or ill, capable or not so capable of achievement, or young or old. The veil makes it difficult to choose social policies (parts of the social contract) that favor one position (e.g., to each according to need) over another.

No Rawlsian society has ever been constructed and it is not at all clear that people of one culture would agree on the principles or that people from different cultures would arrive at the same principles. The problems of cultural relativism seem inevitable. However, even if no such society has been created, the thought experiment compels consideration of what the characteristics of such a society ought to be and how closely present social contracts come to justice for all.

Even though most citizens of most societies do not think often, or perhaps, not at all, about agriculture and its practitioners it is reasonable to propose that agriculture has obligations and can expect rewards under all social contracts. The first expectation of agriculture's social contract is production. Those who practice agriculture are expected to provide food for those who do not. Failure to do so will violate the unwritten terms of the social contract. Secondly, because agriculture is the largest and most widespread human interaction with the environment, its practitioners are expected to care for the environment. Perhaps they do not do that well, but the expectation is real. Finally, those engaged in agriculture can expect a reasonable reward. Government subsidies (albeit primarily for a few major crops: wheat, corn, soybeans, cotton, and tobacco) are evidence of societal concern for agriculture and of the inadequate rewards the free-market system provides for production and environmental care.

Virtue Ethics

Rachels (2003) defines a virtue as "a trait of character, manifested in habitual action that is good for a person to have." Kidder (1994) and Josephson (1989) enumerated some of the habits and actions a virtuous person demonstrates. In

general we like to believe that a person will do well by doing good, by acting virtuously, or, at least, by avoiding doing bad (Blackburn, 2001). Different roles may demand different virtues, a farmer, mechanic, or a teacher can each be virtuous but the specific virtues are different (Rachels, 2003). We recognize those traits that all virtuous people seem to share such as compassion, dependability, fairness, honesty, loyalty, patience, and tolerance (see—universal values, above); the shared traits and actions that speak to our common humanity. They are the characteristics of a good person, who, one presumes will also act in accordance with virtue. Most philosophers regard virtue theory as part of an overall ethical theory rather than as sufficient unto itself. Virtue theory tells one how to act and what characteristics are good but it does not lead one toward a complete conception of the reasons why particular actions are right.

The essence of virtue theory is to ask what traits of character make one a good person? In agriculture one can ask what traits of character make one a good farmer, rancher, or citizen? The extensive work of Wendell Berry draws heavily on a virtue perspective to describe the value of family farms and farmers. Much of his work relies on the thought of Thomas Jefferson, who in his Notes on the State of Virginia said: "Those who labor in the earth" have (if anyone has) been chosen to receive God's "peculiar deposit for substantial and genuine virtue." Those who cultivate the earth are the most valuable citizens. They are the most vigorous, the most independent, and the most virtuous because they are tied to their place by lasting bonds. Jefferson and Berry (1984) regard a farmer's self-interest as coincident with the public good. But family farms in the U.S. are failing and as they are lost, Berry (1984) suggests we lose virtues, important to our society, that they embody and perpetuate. When we lose the family farm or ranch, we lose "much that we need as human beings: a daily personal relationship with nature; a social contract that works; a sense of connection with others; a sense of inhabiting a place for the long haul" (Knize, 1999). Berry (1984) suggests the family farm is failing because it belongs to a value system and a kind of life (a virtuous life) that are failing. As family farms fail, local schools, local businesses, the domestic arts of homemaking, and cultural and moral traditions, are also failing. The loss of family farms is coincident, in Berry's view with the loss of the desirable societal virtues of thrift, generosity, and neighborliness.

Most will agree that the traits Berry (1977) describes as those of the generalist are virtuous (see Chapter 6). They are: caring for the environment, regard for the health of all creatures, an awareness of the importance of the carrying capacity of the farm or ranch and thus environmental carrying capacity, working well as opposed to working quickly, a regard for the natural order of things, an emphasis on serving a place (a community) rather than an institution or an organization, and the ability to think qualitatively (how good or how well) rather than simply quantitatively (how much). Most people would regard these traits of character as virtuous and desirable in any occupation. Those in agriculture who have them will do good things and achieve good results.

If a virtue is a trait of character manifested in habitual action (Rachels, 2003), are there specific agricultural actions, in addition to the generalist traits identified by Berry (1977) that are agriculturally virtuous? Clearly the answer is Yes, but examples are required. A farmer or rancher who allows the land to erode while gaining short-term profit from such neglect is not acting virtuously. The person is a bad farmer or rancher who may be temporarily doing well by practicing bad agriculture. An ethic of virtue includes or presupposes an ethic of right conduct (Holmes, 1993, p. 80). Sandler (2004) says that "the promotion of a technology must not be contrary to justice" (a virtue), as it would be if those who benefit from the technology are not those who bear its burdens. Pesticides benefit users and developers but the external costs, which are often quite high, are borne by all. Sandler (2004) also notes the case of farmers whose tax dollars are used to support research at public universities to develop genetically modified organisms that may harm the farmers compelled to pay taxes to support the research. Compelling, virtue based arguments, raise objections to such actions. Sandler (2004) proposes there is no compelling aretaic (virtue based) "considerations for promoting the genetically modified soybeans, corn and cotton that currently make up nearly the entirety of genetically modified plants cultivated in the world." The basis for his claim is that the activity is not virtuous because it has done little or nothing to relieve suffering of the poor, eliminate global inequality, or reduce the negative ecological effects of modern agriculture.

Deontological or Kantian Ethics

The German philosopher and devout Christian, Immanuel Kant (1724–1804) described a demanding ethical standard, he called the categorical imperative: "Act only on that maxim through which you can at the same time will that it should become a universal law." The operative words under this ethical stance are right and wrong as applied to intent. Consequences are not unimportant but intention is paramount. Personal happiness achieved through ethical egoism is not an objective of Kantian ethics, in fact it is unimportant. Kantian ethical standards are much more demanding than other ethical positions. They say that independent of one's wishes, all people have a moral duty to act in certain ways. One ought not to lie, cheat, etc., period, when one's spouse is dressed and ready to go to a special event and enters the room and asks, "How do I look?" If one wills that it is wrong to lie, then the truth must be told, regardless of the consequences. It is a demanding moral standard.

Creating universal moral laws becomes a problem when those laws create conflicts. One of the clearest examples is the well-known Dutch fishing boat story. The Captain of the Dutch fishing boat had picked up several Jews during World War II. With the Jews in the hold, the boat was proceeding to a safe harbor when a Nazi patrol boat appeared and stopped the fishing boat. The Nazi Captain asked

who was aboard. One is not to lie, ever, and one also has a duty not to allow the murder of innocent people, which is exactly what the Dutch Captain knew would happen if he told the truth. The absolute rules of Kantian ethics do not help much with this kind of dilemma where two absolute rules—do not lie, do not cause harm to others, conflict.

However, many claim that there are some things that just should not be done, ever. I expect most humans and most societies would agree that no one should be another's slave. No person (and perhaps no society) should kill humans randomly. Children should never be tortured. Rape is always wrong. It does not matter how much personal pleasure may be gained or good that may be accomplished by doing one of the above things, they are never right, never acceptable in civilized society. Humans have a duty to do what is right, because it is right. We do what is right not because it makes us happier, is convenient, or makes money, we do it because it is the right thing to do, regardless of the consequences, which are often nearly impossible to know in advance. We do right acts not because we achieve what we want but because they are always right.

Can such absolute rules be applied to agriculture? Some suggest that agricultural practice should never cause environmental harm, that animals should never be treated cruelly, that water should not be mined to produce crops. These matters are not debated actively within the agricultural community that seems to resist absolute moral standards, unless it is the imperative to produce more. The inevitable debate about the appropriateness of absolute moral standards in agriculture will benefit from Rachels' (2003, pp. 127–129) analysis of Kant's basic idea—the requirement for absolute moral rules. It is generally agreed that many pesticides can harm humans, harm non-target species, and pollute the environment. None of these is a good thing and if the maxim is similar to the medical maxim—do no harm, pesticides would be forbidden. However, it is possible to conceive of conditions where continued pesticide use would be permitted. That is, even though bad consequences could follow, there might be circumstances where use would be acceptable. Rational human beings may violate an absolute rule against polluting the environment, if, and only if, we do so for reasons that we would be willing for all to follow. Sandler (2004) suggests that genetic crop modification can be acceptable if it is the only reasonable solution to prevent mass human starvation and the environmental risk is trivial. Rules need not be absolute if the reasons provided for violating the rule are good enough for us to be willing for all to accept the action. The agricultural community has not debated its rules for action and under what conditions it might be acceptable to violate or modify an absolute rule.

Utilitarianism

Utilitarianism was developed by the British philosopher Jeremy Bentham (1748–1832) and elaborated by John Stuart Mill (1806–1873). It judges actions

by their tendency to create the greatest balance of happiness or pleasure over pain or suffering for all affected by an act. The goal humans share no matter what they do, according to Bentham (1879), is to avoid pain and secure pleasure. That is what happiness is. Happiness, pleasure, pain, and suffering are words that lack precision, but inevitably refer to something that is experienced or felt. They are in Damasio's (1999) words—the feeling of what happens. Therefore, consciousness is assumed.

An important qualifier, within the utilitarian standard, is that each person counts for one and not more. That is, all affected by an act are given equal consideration. The operative words in this ethic are good and bad as applied to consequences. The utilitarian claims that actions are to be judged right or wrong solely by the consequences that follow. In contrast, Kant emphasized the primacy of intent, not results. Bentham's "Principle of Utility" requires that when there is a choice between actions or social policies, one must choose that which has the best overall consequences for all who will be affected by the act. After an act has been done, the utilitarian standard requires that the consequences be assessed by the amount of happiness or pleasure that is created and its balance over pain and suffering. The goal is to increase the former and eliminate or decrease the latter. Happiness is the only good that matters because it is intrinsically good.

But are consequences really all that matter? Good consequences are often the result of bad intentions, although both may look the same. Moses Maimonides (1135–1204), the great Spanish Rabbi, philosopher and physician distinguished among seven levels of charity, Singer (2000, p. 258) describes briefly. The lowest level is to give reluctantly. The second is to give cheerfully but not in proportion to the distress of those in need. Next is to give cheerfully and proportionately, but only when asked. The fourth level is to give cheerfully and proportionately without being asked but to give directly to the needy person and potentially shame them. The fifth level is to give so that the recipient does not know to whom one has given but the recipient knows who the giver is. In the sixth case, one knows who the beneficiary is but remains unknown to them. Finally, one gives so one does not know who one gives to and the recipient does not know who the giver is. When considering these seven cases, one wants to say that consequences, which may be the same in each case, are not all that matter, intentions differ among the seven levels of charitable giving and intentions matter. We want to give more credit, more recognition to the person who gives in the latter way than to one who humbles the recipient or one who wants to gain public credit for a charitable act. The utilitarian standard does not allow us to distinguish between them.

In agriculture and in its sub-disciplines the good consequence emphasized as a justification for action is production of abundant, safe food and fiber. It is undeniable that food and fiber production produce great happiness among all who are fed and clothed. The agricultural debate then should not be about this good

utilitarian goal. It should be about the reasons that support the primacy of production as the best goal and about the techniques used to produce food and fiber. Production is used to justify environmental, human, and non-target species harm (Dundon, 2003). Environmental protection is not ignored but it rarely rises to first place in the utilitarian calculus of what agriculture ought to do. Questions of justice for agricultural workers are not ignored, but do not have sufficient force to counter the arguments of the need for ever greater production and profit. Family farms and those who work them, the communities, and local businesses they support (see Goldschmidt, 1998) can be sacrificed to large, more economically efficient farming operations. Economic rationality rules and justice is not considered. Economic rationality has a role to play in agricultural decision making, but decision making should not stop with determination of the most efficient use of resources (Dundon, 2003; Madden, 1991). Efficient resource use does not consider, indeed it may often ignore, achieving the greatest level of happiness over suffering for all affected by an agricultural act. The utilitarian standard requires that all affected by an act count equally but many agricultural decisions that focus on total production or productive efficiency per person do not pause to consider who will be affected or what the human or environmental effects of an action will be.

A major part of the justification for agricultural pesticide use is productive efficiency. Hand weeding and hoeing are arduous, unpleasant tasks. Herbicides are easy to use, much more economically efficient, and increase crop yield. What happens to the labor displaced has not been considered by weed scientists. The productive efficiency of pesticides also trumps real harm to farm workers. They don't count for much so just treatment is often denied so profit and production can be maintained or increased. In fact, pesticide use often denies the right not to be harmed (Dundon, 2003). A major critique of utilitarianism is that people's rights may be trampled because good results defined as higher production will be achieved.

Agriculture and those who practice it have, in my view, a clear utilitarian standard that is unexamined. Because food production is undeniably good, the importance of other elements of utilitarianism—justice, who counts, rights—are ignored. Of course, it is impossible for anyone to consider everyone who could, in theory, be affected by an agricultural act. What is a farmer in the Missouri river drainage of eastern Montana to do when she learns that nitrogen fertilizer used to produce the lentils and sunflowers grown on her farm also is, in theory, harming fish, shrimp, and fishermen in Louisiana who depend on the waters of the Gulf of Mexico for their life or livelihood? It may be that the utilitarian standard is too demanding. Must that Montana farmer consider the children of the fisherman in Louisiana? They will never meet. The farmer has her own children who are primary. Should one (can one?) be required to sacrifice one's own happiness for the presumed happiness of distant, unknown people? In addition, it is impossible for us to consider all as equal. Certainly my children and my

spouse are more important to me than yours. My neighbors are more important than distant people. I am charged to be my brother's keeper, but utilitarianism does not help me know who my brothers are.

Rachels (2003) notes the objections to utilitarianism but doesn't relieve us easily of the obligations. It may be true that justice and human rights may be denied and personal obligations may be distorted or abandoned, if we adhere too closely to the demands of utilitarianism. However, it is a clear moral standard that provides a good guide for choosing the rules that govern how we practice agriculture. It is not just individual acts (Act Utilitarianism) that matters but the set of rules (Rule Utilitarianism) that is optimal from a utilitarian point of view (Rachels, 2003, p. 113) that are most important. Individual acts (use of nitrogen fertilizer in Montana) will be judged right or wrong according to their acceptability under the optimal utilitarian rules. The debate to determine what the best rules are has barely begun within the agricultural community.

APPLYING ETHICS IN AGRICULTURE AND AGRICULTURAL SCIENCE

This chapter began by suggesting that discussion of ethics in agriculture should not be regarded as something that is so scholarly that it risks being unaware of the realities of agriculture or the realities of the ethical life. That is, ethics should not be regarded as just an academic matter. The preceding, albeit brief, discussion of ethical theories is very relevant to agricultural practice. The ethical theories and the values that undergird them, even when unknown and unexamined, are present in agricultural practice. The implicit utilitarianism of agriculture and agricultural science, even though it is often unknown to those who espouse it, is the common justification for action: to provide the greatest good for the greatest number of people. It provides the reasons why agriculturalists do what we do. Exploration of reason is essential to address agriculture's many problems. However, it is highly likely that the implicit, unexamined utilitarian ethic that pervades agriculture is an ethical bias and prevents agriculture's practitioners from dealing openly and honestly with ethical challenges. If one is already sure that agriculture and agricultural technology are ethically correct because production, the highest value, benefits the greatest number, then there is no necessity to explore ethical challenges to this position.

In agricultural practice one often encounters what James (2003) identifies as Type I and Type II ethical problems.[2] Type I problems are important because of

[2] The terms are similar but James' (2003) use of Type I and II ethical problems is not identical to the use of these error terms in statistics. In statistics, a Type I error occurs when the null hypothesis is rejected when it is true and a Type II error occurs when the null hypothesis is accepted when it is false.

difficulty in deciding what ethical norm should apply. Different individuals have different and conflicting values or ethical perspectives. The utilitarian goal of achieving the greatest good for the greatest number via more production may not justify all actions. For example, weed scientists recognize and applaud weed science technology because it is labor saving. Weeding, especially hand hoeing, is an arduous task that no one likes to do for long or to impose on another. Weed control techniques that save labor are regarded as good but if the development of labor-saving technology results in loss of employment for developing country people that may be bad. Some will claim that it may be better to have a job weeding than no job at all. But, one must ask if weed scientists should work to reduce the arduous labor involved in weeding crops even if that leads to unemployment of people with few or no options for employment? Labor-saving technology is good for large farms and for profit but it may be harmful to laborers who lose jobs and to small farmers who are driven out of business because they cannot afford the new technology. What ethical standard, what moral theory should be used to decide? The same arguments apply to development of labor-saving agricultural machines.

There is a tendency in agriculture to rely on technology to solve the problems it creates. A new, better pesticide will solve the problems the old one created. A more efficient machine (usually a larger, more expensive machine) will solve more problems. New cultivars, resistant to a disease or an insect, will be better until they too fail. Sandler (2004) claims that the advent of biotechnology is "another attempt to meet our material needs by domination and manipulation" of nature. He points out that it is doubtful that most scientists, politicians, and business people who advocate biotechnology think of themselves as promoting a detrimental practice of domination (see Federoff & Brown, 2004, for the opposite view of biotechnology). Nor are they motivated by a desire to do so, but that, in Sandler's (2004) view is "exactly what they are attempting to do." Biotechnology is "within the tradition of manipulating and dominating the agricultural environment." It fails to exhibit the requirements of virtue because it illustrates hubris not humility. However, from a utilitarian perspective it may be good because many people will benefit. Arguments on both sides of these issues are reasonable and the result is what James (2003) calls a Type I dilemma (because of the difficulty of deciding what ethical norm should apply) such ethical dilemmas are largely ignored within the agricultural community.

Type II dilemmas are also common in agriculture. These dilemmas occur when there is a general social consensus on what ought to be done but there is significant incentive to violate the social consensus, that is, to violate the social contract. There is consensus that those engaged in agriculture should not do things that lead to irrevocable environmental or human harm. Widespread use of pesticides may lead to both. Pesticides used for crop protection in the world's developed countries have been used improperly in developing countries and manufacturers have often been fully aware of improper use, do not approve it,

but may be unable to stop it short of withholding the product from the market. Other pesticides have been tested and used in developing countries but have not been marketed in developed countries because of environmental, human, or non-target harm. That is, someone decided to use developing country agriculture and people as test cases for pesticide development in full knowledge of the potential for harm. Such testing could never have been done in the U.S. because more stringent health and environmental regulations prohibit it. These illustrate Type II problems where one knows what ought to be done but proceeds to act against the consensus because the potential for profit encourages, or loose environmental regulations permit, the action. Even U.S. farmers may use a pesticide when they know it is not permitted (illegal) but they also know the pesticide works well.

The latter case is illustrated well by the example of the effective carbamate insecticide/nematicide, aldicarb (trade name = Temik). It was approved for use in several crops including cotton, beans, oranges, peanut, pecans, sorghum, soybean, sugar beet, sugarcane, and sweet potato. It has high acute mammalian toxicity (LD_{50} = 0.93 mg/kg) and has some soil stability plus water solubility that have led to its being found in groundwater after use over several years. For many years it was regarded as a safe, environmentally favorable, specifically targeted and especially effective insecticide. It was soil applied and incorporated as a granular formulation.

In 1985, aldicarb appeared as an illegal and toxic residue in watermelons in California and Oregon (Green et al. 1987; Marshall, 1985; MMWR, 1986). It was not registered for use on watermelons. It could have been applied illegally and therefore would illustrate a Type II problem. It could have been applied by someone other than the grower as a criminal act, or it could have resulted from soil residues after legal use on a preceding crop.

The presence of aldicarb was discovered and a food alert was broadcast by the California Dept. of Health Services and the Oregon Department of Agriculture on the July 4th weekend. The alerts suggested that anyone with cholinergic symptoms that appeared within 2 hours of eating a watermelon should see a physician immediately. The symptoms included twitching, uncontrolled muscle activity, nervousness, and anxiety. Such symptoms occur because aldicarb interferes with the action of acetylcholine, which is important in transmission of nerve impulses. In Californina, 1350 cases were reported from all regions and 493 were classified as probable by the State Health Dept. (MMWR, 1986). Oregon reported 206 cases with 27 probable (Green et al. 1987). There was a huge public expense and a massive public alarm created by a few watermelon growers who may have done what they knew they should not do to protect a valuable crop that lost much of its value because of what they did. Eventually all watermelons in the California distribution chain were destroyed and Oregon recalled all watermelons.

A similar although less consequential Type II error is illustrated by a Wyoming rancher I met several years ago. He had a supply of, and regularly used, the highly

effective but unapproved (for the particular use) broadleaved herbicide, Tordon. He knew it was illegal but, in his words, "It sure works to kill them larkspurs (a poisonous weed) and if I don't kill 'em, they will kill some of my cattle."

Thus, we observe conflicts between moral rules leading to Type I problems that can be solved when reasoned discussion occurs. We also observe Type II problems where people do what they know they should not do because of other benefits. That is people give higher value to production, efficacy, or the potential for economic gain than they ought to. Other agricultural examples can be found in Conroy 1996; Murray 1994; and Wright 1990.

Steinbeck and Ricketts (1941) accurately characterized the ethical dilemma that one finds in agricultural and other fields of human endeavor. It involves the difficulty of deciding what ethical norm should apply (a Type I error) or the equally vexatious problems of knowing what the general social consensus is but proceeding to violate it because there is significant incentive to do so (a Type II error) (James, 2003).

> There is strange duality in the human which makes for an ethical paradox. We have definitions of good qualities and of bad; not changing things, but generally considered good and bad throughout the ages and throughout the species. Of the good, we think always of wisdom, tolerance, kindliness, generosity, humility; and the qualities of cruelty, greed, self-interest, graspingness, and rapacity are universally considered undesirable. And yet in our structure of society, the so-called and considered good qualities are invariable concomitants of failure, while the bad ones are the cornerstones of success. A man—a viewing point man—while he will love the abstract good qualities and detest the abstract bad, will nevertheless envy and admire the person who though possessing the bad qualities has succeeded economically and socially, and will hold in contempt that person whose good qualities have caused failure. When such a viewing-point man thinks of Jesus or St. Augustine or Socrates he regards them with love because they are the symbols of the good he admires, and he hates the symbols of the bad. But actually he would rather be successful than good.

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CHAPTER 5

Moral Confidence in Agriculture[1]

Ethics is about what individuals, groups, and societies ought to do. Ethical analysis involves thought about and analysis of what one does and attempts to provide reasons, based on moral theory, to show why one's actions are the right things to do. It must probe stated and unstated goals and the values presupposed by them. A good analysis will try to develop a rational way of deciding how an individual ought to live and how a profession ought to proceed toward realization of its goals (Singer, 1994). Such an analysis might lead one toward a set of "rules, principles, or ways of thinking that guide, or claim authority to guide, the actions of a particular group" (Singer, 1994). It will make explicit what is valued and may lead to action on those values.

This chapter argues that those engaged in agriculture, whether practitioners, research scientists, extension agents, technology developers, or technology suppliers share an unexamined moral confidence about the goodness of their activity. The chapter also argues that the basis of that moral confidence is not obvious to those who have it or to those not involved in but who may be curious about agriculture and its technology. In fact, the moral confidence that pervades agricultural practice is potentially harmful because it is unexamined by most of its practitioners. Regular debate about ethics and the applicability of moral theories to agriculture have not been part of intellectual discourse within agriculture.

Perhaps the best that can be sought in the moral realm is not absolute certainty but the best available option, which many defenders of agricultural practice appear to believe is what we now have. We live in a world of moral ambiguity, but it is also a world where some moral values seem to have been accepted by all cultures (Josephson, 1989; Kidder, 1994; Krober & Kluckhohn, 1952). No culture tolerates indiscriminate, harmful lying, stealing or violence; incest is universally forbidden; no culture values suffering as a desirable goal; all

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cultures have death rituals; protecting children is universally regarded as good in civilized societies; and all societies despise cowardice and applaud bravery.

Even though there is moral certainty on these matters among cultures, that same degree of moral certainty may not be desirable or achievable for the world's major environmental interaction—agriculture. Absolute moral certainty and the consequent lack of moral debate may stifle discussion and progress. Debate about what agriculture ought to do, rather than agreement on what agriculture must do or be, is preferred. Debate about morality should reveal the foundational theories (see Chapter 4) and values and thus provide a guide for action. Moral theories are the, often invisible, foundation on which our judgments rest. Exploration of foundational theories (perhaps among those described in Chapter 4) will expose them to debate and discussion. When one understands the foundation of moral judgments, that understanding ought to lead to more confident judgments but foundational values are not the answers to problems. They are ways to assist in constructing the personal, social, and cultural world we inhabit. Exploration of the moral confidence posited for agriculture will not reveal a single guiding principle the use of which will solve all moral dilemmas in agriculture. It will reveal several principles that are used in the morally ambiguous, pluralistic world in which agriculture is practiced.

THE BENEFITS AND COSTS OF MODERN AGRICULTURE

Hugh Sidey, a contributing Editor of TIME magazine, delivered the 1998 Henry A. Wallace lecture to the Wallace Institute for Alternative Agriculture on "The Greatest Story Never Told: The Food Miracle in America." Sidey (1998) quotes Dumas Malone, a biographer of Thomas Jefferson, who said, "The greatness of this country was rooted in the fact that a single farmer could produce an abundance of food the likes of which the world had never seen or imagined, and so free the energies of countless others to do other things. So much of recorded history is about the struggle of individuals and families to feed themselves. That changed dramatically in this country." Sidey contends that the story of the productivity and success of American agriculture is the greatest story never told. Few, if any, other segments of the American scientific-technological enterprise have amassed such an impressive record of predictive, explanatory, and manipulative success over many years. American agriculture has been a productive marvel and is envied by many other societies where hunger rather than abundance dominates. Examination of the yield records for nine major crops[2] in the U.S. during the twentieth century shows that yield increases have varied from two to sevenfold (Warren, 1998). No yields decreased. Scientific advances that led to these steady yield increases include development of higher yielding cultivars; synthetic

[2] Corn, cotton, peanut, potato, rice, sorghum, soybean, tomato, wheat.

fertilizers; improved insect, weed, and disease control; better soil management; and mechanization. Warren (1998) suggested that the rate of yield increase does not appear to be slowing. Avery (1997) points out that without the yield increases that have occurred since 1960, the world would now require an additional 10 to 12 million square miles (roughly the land area of the U.S., the European Union countries and Brazil combined) for agriculture to achieve present levels of food production. Avery (1997) claims that modern high yield agriculture is not one of the world's problems but rather the solution to providing sufficient food for all, sufficient land for wildlife, and protecting the environment.

Degregori (2001, p. 7) sees the dilemma of agriculture and its modern technology as "one of the great paradoxes of the twentieth century." He argues that the "century was characterized by economic and technological gains of unprecedented rapidity as shown by all economic indicators." The non-economic indicators (life expectancy, human health, and the increase in per capita food supply "were just as spectacular" and fed an increasing population that all experts believed could not be fed. The paradox is that the agricultural and other technology that allowed much of this to happen, have been "under attack for almost the entire century." Degregori (2001, p. 8) believes the attack has been unwarranted and is not supported by the evidence and represents a pervasive anti-technology bias. In his view, much of the difficulty of discussing the issues surrounding modern agricultural technology is "that public discourse is being driven by emotional language" (Degregori, 2001, p. 125). He is correct but his accusation fails to see the relevance of such language as pointed out above in Chapter 1. Degregori agrees with Avery and Sidey in his claim that "the anti-technology, antirational views that have gained such a stronghold in many areas of academia and other elite groups" and that they will have adverse consequences for many of the world's vulnerable people. The view is that technology is not the problem, it is the solution to a host of problems.

American agricultural producers and research scientists are proud of their achievements. Our food production system, including growing, distributing, processing, and preparation, are now all part of a large, vertically integrated commercial system (Blatz, 1995). The family farm as an independent, self-supporting entity and a cultural icon is dying. The agricultural legacy that came from family farms is the heart of the Jeffersonian agrarian tradition that few Americans now experience but most value. It no longer serves as an immediate, experiential source from which citizens derive social values or moral sustenance.

The abundant production that all involved in agriculture value highly is, in Berry's (1977) view, illusory. Berry (1977) argues that the abundance is illusory because "it does not safeguard its producers, and in American agriculture it is now virtually the accepted rule that abundance will destroy its producers" and the land base. The evidence supports Berry's prediction. Stauber et al. (1995) provide census data that verifies farm population decline from 1940 to 1990 in Iowa (72%), Minnesota (77%), Montana (74%), and North Dakota (82%). Stauber

et al. (1995) also show that as farm population declined farmland remained nearly constant because farm size increased in Iowa (88%), Minnesota (89%), Montana (121%), and North Dakota (123%). A 1998 U.S. Dept. of Agriculture report found that 300,000 small family farms went out of business between 1979 and 1998 while the share of agricultural dollars received by farmers dropped from 21% in 1910 to 5% in 1990. Our government paid $114 billion for farm subsidies between 1995 and 2002, but 10 percent of the largest farms (mostly corporate agribusinesses) collect ⅔ of all crop subsidies (Standaert, 2003). In 2001, the number of farms and ranches in the United States declined 0.7% to 2.16 million compared to 2.17 million in 2000. This was the second largest decline in farm numbers since the 1.4% drop in 1991. Total farmland declined 1.9 million acres as average farm size increased only 2 acres from 434 to 436 acres. The number of farms declined in 23 states, remained the same in 22 states and increased in CA, CO, OK, TN, and TX (Alt. Agric News, 2002). Farms are not the only businesses where the number of independent owners has declined. In the decade of the 90s, eleven thousand independent pharmacies closed, more than 40% of independent bookstores failed, and five supermarket firms (Albertsons, Ahold, Kroger, Safeway, and Wal-Mart) surged from controlling less than one-quarter of all grocery sales to 42% (Harkinson, 2004). In addition, Blockbuster rents one in three videos in the U.S., one hundred chains handle 40% of restaurant spending, and "Wal-Mart controls a third of the market for products ranging from dog food to diapers" (Harkinson, 2004).

The effects of these trends in farming and related community businesses were foreseen by Goldschmidt in 1947 and verified in his recent work (1998). He claims that "large-scale, labor intensive, technologically innovative production . . . made industrial farming possible but not necessary; social policies were needed for that." These policies that made the decline of family farms inevitable were devised in a system where "social relationships were money-based and social standing was money-driven." The singular goal of the U.S. agricultural system was "to gain wealth, without the least concern for the welfare of those whose lives" were being destroyed. There was also no concern, or, at best, minimal concern, for the effects of the money driven system on the environment on which agriculture and life are dependent. The monetary rewards of the agricultural system are handsome for the survivors—profit. The social rewards of belonging to a caring community, the spiritual satisfaction of serving a larger public purpose, and the communities themselves and the businesses that they support have been sacrificed to the bottom line (Goldschmidt, 1998). These losses are the social costs of technological improvements in agriculture. They are neither necessary nor desirable. Goldschmidt (1998) argues that these losses are not trivial and should not be thought of as simply the inevitable price of progress. He argues that the changes in agriculture have made a big, and largely unnoticed, difference to our nation. His work supports the inevitability of the decline of other small businesses as small farms disappear.

The highly productive agriculture that Sidey (1998) applauds, is a business like any other business where producers seek high production at low costs. Each strives to adopt new technology rapidly to stay ahead of other producers and gain a competitive edge that leads to greater profit. The idea is not to work out ways for all to thrive, but to gain as much of the market and profit as possible so others cannot (Blatz, 1995). If a neighboring farmer's autonomy or survival is threatened by this system, it is not viewed as a systemic problem but as the neighbor's failure to adapt and survive. U.S. agriculture has become industrialized not only in terms of its size and methods of operation but in the values its practitioners espouse. The guiding purpose of each farmer is to produce as much as possible at the lowest cost of capital and labor to generate maximum profit (Blatz, 1995). Much rhetoric is heard about the necessity and obligation of American farmers to feed the world through our production, which Keeney (2003) considers to be a goal that has failed U.S. agriculture. The failure is a combination of technologies that have pushed farmers off the land, few new markets, and an environment that suffers from soil, nutrient and pesticide runoff (Keeney, 2003).

We also hear that keeping food costs low for consumers is a requirement of our system in spite of the fact that both of these goods lead to the moral wrongs that Berry (1977) deplores: the destruction of producers who care for each other and the destruction of the land. It is reasonable to claim (Berry, 1977; Blatz, 1995; Jackson, 1980) that the highly productive, capital, energy, and chemically intensive American agricultural system is environmentally unsustainable at present levels of production. It is also reasonable to claim that U.S. food costs are not low. Low cost is an illusion because we actually pay for our food three times. We pay first when we buy food, a second time when we pay Federal taxes that support massive farm subsidies, and finally when we pay for the environmental clean-up and health care costs that arise from agricultural pollution (Pretty, 2003).

At this point, many readers will assume that this chapter will plead for a return to small-scale farming and for support of the possibly false claim of the moral virtue of family farmers and farming communities. The author, a Luddite, wants to abandon the great achievements of scientific agriculture. On the contrary, the quantitative claims of U.S. agricultural abundance are true. Sidey (1998) is correct. But blind acceptance of that fact may lead societies to assume that agricultural abundance is assured. No society should assume its agricultural abundance is assured, and the system that produces food should not be regarded as similar to a factory that, with the right inputs, can manufacture abundance at will (Blatz, 1995). Food is essential to life but it comes from the land, not from money (Berry, 1999). Therefore the land that produces food is essential. If the foundational values of the food production system do not place protection of the land, the source of agricultural abundance, as an essential part of human life and instead regard food as just another industrial commodity that can be purchased by those with money, then the ethics of the system ought to be a subject of societal concern.

It is common knowledge that the poor are hungry, even in the richest countries. It is a problem not amendable to an easy technical solution or social algorithm that will lead to its solution everywhere or quickly. In face of the undeniable success of agriculture in the developed world, its practitioners should at least ask the qualitative question about whether hunger is a problem of insufficient production, inequitable distribution, or irresponsible consumption by the rich (Thompson, 1989). Many, certainly not all, agriculturalists often see more production as the solution because they consider hunger to be primarily a problem of insufficient production (Avery, 1997). The other possibilities, inequitable distribution of abundance and over consumption (see Halweil & Mastney, 2003) are not considered or are readily dismissed.

As agriculture's productive capabilities have been enhanced by science-based technological discoveries it is not surprising that the pursuit of production has conflicted with other societal values (Thompson, 1989). Any technology has effects in addition to those intended. For example, air in urban areas is polluted partially because of automotive exhaust: an unplanned effect. Similarly, agricultural technologies have undesired and often unanticipated effects (Thompson, 1989). As mentioned in Chapter 1, nitrates from fertilizer increase production and pollute water. New cropping techniques may expose soil to excessive erosion. Monocultural agriculture leads to loss of species diversity. From 1903 to 1983 U.S. agriculture has lost 80.6% of tomato varieties, 92.8% of lettuce varieties, 90.8% of field corn and 96.1% of sweet corn varieties, 86.2% of apple varieties, and only 4 potato varieties are grown in the U.S. (Kimbrell, 2002, pp. 71–81). Many technologies save labor but do not consider what happens to the people whose jobs are lost. Pesticides increase production by limiting pest damage, but they pollute soil, air, and water and harm non-target species. New agricultural technologies have reduced the risk of production failure for producers but increased the risk of harm to other species, including humans. Agricultural technologies are significant contributors to the pervasive environmental and human health problems that identify modern society (Gerrard, 2000). Advances in medicine and environmental science have made all of us more cognizant of risks that may have been unknown in the past (Thompson, 1989). Agricultural technology has always exposed people to risk. In the past, most of the risk was borne by the user of the technology. Now many risks of agricultural technology are known, and it is known that they are borne by users and others. Technology developers, sellers, regulators, and users, in their moral confidence have not secured or even considered the importance of securing the public's consent to use production technology that exposes people to involuntary risk (Thompson, 1989). For example, with the present U.S. population (approx. 290×10^6 in 2002) and the fact that 1.24 billion pounds of pesticides were used in the U.S. in 1999 (5.7 billion were used in the world), one can only conclude that 4.3 pounds of pesticide are being applied somewhere by someone for every American. Annually, we voluntarily consume 5 pounds of butter per capita and 8 pounds of coffee,

neither of which may be good for perfect health. But to think that each of us may be involuntarily exposed to 4.3 pounds of pesticide bothers a lot of people. It is no longer sufficient to claim that all is well as long as those who use pesticides do so in accordance with label directions. It is insufficient to claim that there is not a problem with pesticides, people just think there is. That is not a moral argument. At best it is an incorrect empirical claim.

Thompson (1989) says:

> Agricultural producers and those who support them with technology may have been seduced into thinking that, so long as they increased food availability, they were exempt from the constant process of negotiating and renegotiating the moral bargain that is at the foundations of the modern democratic state. Democratic societies will not entrust their water, their diets, or their natural resources blindly into the hands of farmers, agribusiness firms, and agricultural scientists. Agricultural producers must participate in the dialogue that leads to social learning and social consensus about risks, and they must be willing to contribute the time and resources needed to understand the positions of their fellow citizens, and to make articulate statements of their own position.

For most non-agricultural segments of society, these are not new demands. For agriculture they are. Agriculture has been so confident of its narrow pursuit of increased production that its practitioners have frequently failed to listen to and understand the position of others (e.g., environmental groups, modern agrarians, organic practitioners). The claims of those who object to modern agricultural technology are rejected as unworthy of serious thought. That represents a risky narrowing of viewpoints (Gerrard, 2000). As pointed out by Feyerabend (1987, p. 34), who cites Mill, views one may have reason to reject may still be true and rejection of those views without careful consideration implies infallibility on the part of those who reject. It also fails to recognize that even though the bulk of a view may be wrong, some useful truth may be present. No one view ever has all the truth. Alternative views help hone and sharpen one's view and defenses against objections. Thirdly, and this appears to be common, a refusal to address alternative views, to debate, leads to one's view becoming just a prejudice. Finally, only by considering contrasting opinions can one understand the true meaning of one's view of any issue. Without contrast, one's view becomes "a mere formal confession" (Feyerabend, 1987).

Agriculturalists have not taken the time to articulate any value position other than the value of production and have not articulated the reasons that value ought to retain its primacy. They have not considered other views of issues and their views often become just formal confessions of an unexamined view they assume others will support because it is so logical to them. Unintended consequences of agricultural technology are never just scientific or production questions. They always include a moral dimension that demands thought about fundamental values and the ethical foundation of those values.

HIGHLIGHT 5.1

The dominant social goal for agriculture is to produce abundant food and fiber and to assure producers a profit for their work. The modern, developed country agricultural production system has succeeded well with the production goal but less well with the goal of profit for the producer. Agricultural science and the agricultural establishment (producers, manufacturers, marketers, etc.) have not paid much attention to agriculture's effects on social and environmental goals. These things are often regarded as beyond agriculture's purview. More production is nearly always viewed as better and for the US economy as a whole. Increasing the supply of things seems to be the primary goal of national economic policy.

The US with less than 5% of the world's population uses nearly 30% of the earth's resources to maintain our wonderful lifestyle. We are the world's great consumers. More than 60% of Americans are overweight and that is estimated to cost more than 12% of annual health care expenses. This is all part of what Durning (1992) calls "the conundrum of consumption." It is:

> Limiting the consumer life-style to those who have already attained it is not politically possible, morally defensible, or ecologically sufficient. And extending that life-style to all would simply hasten the ruin of the biosphere. On the other hand, reducing the consumption levels of the consumer society, and tempering material aspiration elsewhere, though morally acceptable, is a quixotic proposal. It bucks the trend of centuries. Yet it may be the only option.

Durning adds the corollary conundrum that "this historical epoch of titanic consumption appears to have failed to make the consumer class any happier." US citizens living in the 90s were, "on average, four-and-a-half times richer than their great-grandparents were at the turn of the century, but they are not four-and-a-half times happier." The Worldwatch Institute reported that the number of Americans who described themselves as very happy declined from 35% in 1957 to 30% in 2001 (Worldwatch Mag. Mar./Apr. 2001).

Thus, it seems reasonable to ask the agricultural community a moral question. Should the endless quest for greater production make producers or US society happier. Should agricultural practices maximize happiness in the US, among farmers and ranchers? Under what conditions should increasing production be reduced in importance when compared to maintenance of small farms and rural communities? Should the agricultural community consider ranking preserving environmental quality ahead of production?

GOALS FOR AGRICULTURE

Production of abundant food and fiber must remain a goal of agriculture. If agriculture does not produce, it fails to fulfill an essential goal of interest to all members of any society. When one asks what agriculture's goals ought to be, reliable production of an adequate supply of safe food must remain near the top of any list. However, because we live in a culturally pluralistic world, we are compelled to ask what other goals ought to be considered by agriculture and when and why one or more of these may take precedence over production. Without describing all possible or desirable goals for agriculture it is possible, for purposes of discussion, to divide goals into two groups: social and environmental.

Social Goals for Agriculture

Proper social goals for agriculture were dealt with by Aiken (1984). He, as Day (1978) did, ranked profitable production as the primary goal of agriculture.[3] Nearly all agricultural practitioners would agree. Aiken (1984) then suggested sustainable production, environmentally safe production, meeting human needs, and contributing to a just social order as additional goals which may often be of greater moral importance than profitable production. This array diverges from the dominant agricultural view. Few agricultural voices speak of achieving a just social order. There is no apparent objection to achieving a just social order but it is not an agricultural goal. Thompson's (1986) analysis of Aiken's (1984) article ascribes the ranking to a straightforward principle for ordering of duties or rights. "The principle would hold that one right or duty is more basic than another whenever the moral benefits associated with the second can be extended to all people only after the first has been protected or fulfilled." Thus, "a right to life is more basic than a right to an education." One presumes that education is desired only by the living and that they must be fed, so the agricultural goal of production of sufficient food is not unreasonable.

Agriculturalists begin to diverge from others when discussion of sustainability occurs. Many in agriculture see sustainability as achievable by modification of the present system and do not countenance abandoning the system that has been so successful. Achieving sustainability is regarded as a scientific matter. However, because agriculture is the largest and most widespread human interaction with the environment, achieving it also has social and ecological effects. Sustainability can be achieved best when the discussion includes consumers and producers (Thompson, 1986) and considers environmental effects. Thus,

[3] A difference is that Aiken (1984) followed with four other goals and compared them. Day (1978) suggested production was the only proper goal for all of agriculture for all time.

achieving a sustainable agricultural system is a societal not just an agricultural responsibility, which should be greeted with pleasure by those in agriculture.

The agricultural market as part of the greater market of all goods and services distributes agricultural supplies to producers and produce to consumers. Markets are very powerful mechanisms, but they often are not just. If they were just, then America would not have hungry people. Those who emphasize the primacy of production must recognize the connection between what is produced, the market that distributes it, and a just social system.

Thompson (1986) acknowledges the persistence of the agrarian ideal in the American mind. As family farms and rural communities disappear, the virtues they instilled in past generations (help your neighbor, be kind to animals, help those in need, respect the family, respect your elders, etc.) are still valued by our society. Churches and schools try to teach these virtues although schools are frequently chastised for teaching values. I suggest that most people still want children to learn what they regard as traditional values and mourn their loss. We cannot figure out how or where to teach what used to be obtained by osmosis from the culture. Thompson (1986) suggests that one way to encourage these values is to have them "prominently displayed in the social purpose of a economically central and vital activity such as agriculture." To accomplish this, those in agriculture are going to have to abandon the singular pursuit of production as their only goal and incorporate the conscious pursuit of social goals as part of the practice of agriculture. This necessitates debating what the right goals are. It also assigns a large task to an already small and decreasing, dispersed minority of the U.S. population. Who will prominently display such values? Who will speak for agriculture?

HIGHLIGHT 5.2

A major environmental pollution problem has been created by confined animal feeding operations (CAFOs). CAFOs house a few thousand to several thousand animals in confinement on a small acreage. They are an economically efficient way to produce pork or chicken with a minimal requirement for human labor. CAFOs are attractive to farmers because it allows them to specialize production operations as they attempt to maintain income. However 400 hogs can generate more than 12,000 gallons of manure each day and disposal is a problem. Neighbors complain of olfactory pollution and the liquid manure lagoons built to store the waste have become part of the problem in addition to the fact that they may rupture and pollute nearby water.

Scientists with the USDA's Agricultural Research Service have developed a combination of technologies that separate solid from liquid waste, recover organic matter, remove ammonia from wastewater, and transform phosphorus

removed from wastewater into calcium phosphate, a marketable fertilizer. The system removes more than 97% of total suspended solids, 95% of total phosphorus, 99% of ammonia, 98% of copper, 99% of zinc, 99% of biochemical oxygen, and more than 97% of odor-causing components of hog manure. This modern, efficient system will significantly reduce the undesirable olfactory effects of CAFOs and permit further expansion of confinement rearing of animals (Anonymous, 2005).

However, publicity about this desirable scientific advance does not even mention any concern about whether confinement rearing of animals causes animals to suffer. Efficiency and profit are all that matter and both will be improved as science eliminates the undesirable environmental effects of CAFOs. Whether humans have a right to treat animals in ways that cause them to suffer becomes an unasked and irrelevant question.

Environmental Goals for Agriculture

Environmental goals for agriculture should not be, and perhaps cannot be, divorced from social goals. Sustainability is regarded by those in agriculture as primarily a production and secondarily as an environmental goal, but others see it as a social goal. The view depends on what one wants to sustain. In agriculture, to sustain usually means to protect the productive resource (soil, water, gene pools) and maintain production. Others will agree that protecting these is important but might rank protecting them below sustaining environmental quality, family farms, small communities, rural life, small businesses that serve agriculture, small communities, and a way of life that can only be achieved on the farm. This is not merely a semantic debate. It goes to the heart of what agriculture ought to do; what values it ought to espouse. Leopold (1947) addresses the essential issue regarding land when he suggests that the last great moral divide is between those who regard land as property that they own and can do with as they please and those who see land as part of the community to which they belong. Leopold (1947) based his land ethic on the absolute human need for community. We humans want to belong. In Leopold's view we need to protect the land so there will be a community left to which we can belong. Agriculture has a major responsibility because it has the potential to care for or harm so much land. This is a different view from protecting land only as a productive resource. Land, as Leopold (1947) claimed is the basis of life. It is the necessary resource for a productive and profitable agriculture (Thompson, 1988). Without the land there will be no agriculture, so land must be regarded as something more than other productive resources (e.g., fertilizer, machines, irrigation water, pesticides, or seed). Its importance to agriculture should not be thought of only in monetary terms.

The ecological imperative of interconnectedness must be stressed more than a simple production ethic allows. To harm or destroy the land is not just a matter of profit and loss because such actions destroy that which is essential to life, and that certainly raises a moral question.

The challenges and problems of social and environmental goals for agriculture are that they involve values as the defining characteristic of the questions raised. It is generally not recognized in agricultural science that values are not peripheral to the science and technology but foundational (Capra, 1996). Scientists know they are responsible for the scientific integrity of their work and for its intellectual contribution. They do not as readily assume responsibility for the moral aspects of their work.

The biotechnology bandwagon, which has captured university, State, and Federal research systems is a good example. Just as the pesticide bandwagon did from the 1950s through the 1970s (Cate & Hinkle, 1993) the biotechnology bandwagon is now rolling. In the earlier era, massive resources turned toward learning how to use pesticides to make agriculture more productive. Now the same institutions are turning from the talents of agronomists, entomologists, pathologists, weed scientists, chemists, and toxicologists to the talents of molecular biologists and biochemists to create new agricultural systems. In the first era pest management problems were solved through chemistry, and now genetic engineering (genomics) is becoming dominant (Cate & Hinkle, 1993). However, agricultural systems are not products to be discovered, wrapped in a shiny package, and sold. They are continually evolving toward changing goals and objectives. Effective management of any pest is fundamentally an exercise in applied ecology (Cate & Hinkle, 1993), which is not achieved by one more product from the genetic engineer or chemist. Neither group has the education and often not the inclination to address the ecological, social, or moral questions that arise. The true social and environmental costs of any technology are rarely measured by the developer. They are not part of most profit and loss calculations, and many such costs are not even known, although all are paid by someone. Pesticide developers have been alerted to ecological, social and moral questions by many authors (Carson, 1962; Murray, 1994; Perkins, 1982; van den Bosch, 1978; Wright, 1990, and others). The current controversy about genetically modified organisms has a familiar ring.

Anyone can dismiss any criticism of technology by saying, "Well, it's not true for me." This makes our personal beliefs, our assumptions, absolutely secure, and then there is no reason for beginning the difficult task of examining them (Melchert, 1995). How any idea strikes us, especially one that is critical of our activity or profession, is not a reliable guide to the validity of the comment or to how we ought to respond. Our first reaction, our intuition, may be mistaken. It is best to know and consider the arguments that support the idea or criticism. In science the data or theory that best explains the observations usually wins. In ethics the best reasons win. It is wise to avoid the temptation to ignore good

reasons that disagree with our assumptions. We may often find ourselves finding the truth we want; not by inventing it, but by allowing the emergence of only the part of the whole truth we want to hear (Barrow, 1995). When agriculturalists think of the future of agriculture, it is important that they recognize that their vision of the future (their truth) affects the decisions they make (Harman, 1976) and how they practice or recommend agriculture be practiced. The research and teaching we do now involves a view of a future we expect, desire, or fear (Harman, 1976). If our view of the future changes, the decisions we make each day change. Our view moves from what is, to how we would like things to be, to what we perceive to be good. We then move quickly to a description of what we ought to do to achieve the good we desire. It is in this transition that we depart from the domain of science and enter the domain of evaluation, from which an ethic can be developed (Rolston, 1975). If the good we desire is inspiring, it will impel each of us and others to action. If our view is uninspiring or wrong, there may be no common image of what is worth striving for. Then a discipline or a profession will decline because it lacks an inspiring vision and adequate motivation.

Most of my colleagues in Land Grant University Colleges of Agriculture are confident that their research and teaching are morally correct. They defend their objective approach to science and their objectivity in defending agriculture and agricultural research against emotional attacks from people who don't understand either. I often hear, "People should not complain about our agricultural system with their mouth full" a conceit that dismisses the complaint without hearing it. The scientist's frequent appeal to the value of objectivity in science is evidence of a lack of awareness of the inevitable subjectivity of science. Neils Bohr, a pioneer in quantum mechanics, suggested the scientifically heretical idea that the mental decisions of the investigator influenced the outcome of an experiment. His point was that the observer somehow created the reality observed (Shlain, 1998). This does not mean that there is no such thing as objectivity or that all of science has to be discarded. It does mean that science has "to admit its nemesis—subjectivity—into its calculations." No science, including agricultural science, is immune to the nemesis of subjectivity. For example, a study done of the faculty of the college of agriculture at Washington State University (Beus & Dunlap, 1992) showed faculty members slightly more in favor of conventional agriculture than farmers statewide were. They were slightly less conventional than proponents of conventional agriculture and far more conventional than known proponents of alternative agriculture. Beus and Dunlap (1992) also found that women, younger faculty, and faculty not raised on farms were somewhat more likely to endorse the alternative agriculture paradigm than their counterparts. These faculty groups have made a transition from the scientific to the ethical realm, perhaps without knowing they have changed. They moved quickly and easily from observation of what is, to knowing that it is good and ought to continue to occur (Rolston, 1975). The supporters of the status quo of conventional

agricultural research direction and practice are morally confident of the rightness of their unexamined position.

An additional example is provided by a series of articles in the High Country News. Jones (1994) accuses land grant universities of having "elevated efficiency and scale of production above all other values." Their efforts have nearly eliminated the original land grant constituency of small family farms because rural people and the environment have not been central concerns. Jones (1994) suggests this is because the faculty and administration are tightly connected with traditional rural interests and faculty have lacked the freedom and encouragement to implement new ideas. She laments the lack of creative ideas flowing from land grant universities about such rural problems as land use planning in rural areas, grazing, or logging. Land grant college faculty, in Jones' (1994) view, have handed over to others the intellectual oversight of major agricultural issues. As apologists for exploitive industries, land grant universities "usually value the economic interests they serve above the public interest" (Wuerthner, 1994). Jones (1994) concluded that the institutions have been challenged and "in their own, ponderous way, they are responding to that challenge." As the Washington State study (Beus & Dunlap, 1992) shows, younger faculty are aware of agriculture's problems and are dealing with them.

EXPANDING AGRICULTURE'S MORAL SCOPE

To suggest expanding agriculture's moral scope is not to suggest that agriculture and its practitioners lack moral standards or that all past achievements and values must be abandoned. It also does not suggest that this book is about to reveal a new, correct set of moral standards for agriculture that will solve the problems. Expanding the moral scope includes asking where moral values come from, and what are or ought to be the source of moral values for agriculture.

The Utilitarian Standard

In fact, as suggested in Chapter 4, agricultural research and agricultural policy have had an identifiable utilitarian ethical standard since inception (Thompson et al., 1991a). The clear emphasis on increasing production and reducing production costs to increase profit identifies the utilitarian ethical standard to provide the greatest good for the greatest number that has been implicit in agriculture (Thompson et al., 1991a). This standard, accepted and largely unexamined within agriculture, has assumed that increasing production and reducing cost will optimize the social benefit of agriculture. There has been almost no dialogue within agriculture about the correctness of the standard for all agricultural issues. One result has been that many scientists, ignorant of their own social context and all results of their technology, have, without questioning, accepted the loss of small

farmers and rural communities as part of the necessary cost of achieving the greater goal of maintaining a cheap food supply (Stout & Thompson, 1991). The utilitarian standard is evaluated in terms of outcomes and agriculturalists use the outcomes that are easily observed to evaluate what they do. They measure total production, crop yields and profit, and the latter, according to the USDA as reported in the Nov. 28, 1999 New York Times, has fallen 38% since 1997. They conclude that their efforts are ethically correct because good results have and, it is assumed, will continue to follow increased production. The morality of an act according to the utilitarian standard lies in its consequences. It does not focus on intentions as other moral standards do (e.g., see Chapter 4). Thus the cry for justice by the poor or the pleas of those concerned about loss of environmental quality are overwhelmed by the achievement of increased production and are often regarded as simply pusillanimous appeals.

Utilitarian thinking allows individual research scientists to believe that each research program is ethically correct because of its perceived good effects. Utilitarian standards are able to assign moral responsibility to any agricultural program or research area without considering the entire system (Thompson et al., 1991b). Agricultural scientists often see agriculture as a system of separable goods (e.g., seeds, bags of fertilizer, liters of pesticide, etc.) rather than as an integrated system. This view is a result of our reductionist heritage. Agriculturalists have learned to deal with highly divisible technologies (separable goods) rather than with non-divisible parts of the system (e.g., tractors, dams, irrigation systems) that demand a more holistic perspective.

None of the foregoing should be interpreted as an attack on the personal moral standards of individual scientists. I assume that anyone who has a research or teaching position knows the ethical norms (Holt, 1997). But as Ruttan (1991) has said, "agricultural scientists have been reluctant revolutionaries." They have wanted to change agricultural practice and results but have neglected the revolutionary effects of their efforts on society. They have believed that their work could be reduced to their little pieces of agriculture and then added to the system without changing the whole system. Increasing production was the goal, and it was believed that could be accomplished without creating or at least without being bothered by the creation of other, revolutionary effects (Ruttan, 1991). The ethical standards Holt (1997) assumes operated only within the immediate confines of the scientific enterprise; all else was external and could, therefore, be neglected. Therefore, agricultural research has been and is done in a morally narrow and ambiguous context with little recognition of either.

The Relevance of the Western Agricultural Model

The post World War II shift in the developed world to intensive farming systems with modern chemical and energy technology led to major increases in plant

and animal production. These systems maximized production through specialization, increased scale of production units, minimized labor requirements, and maximized use of technological inputs. They allowed Western nations to fulfill more adequately than any societies have before what Ponting (1991) calls "the most important task in all human history"—to find a way of extracting from the ecosystem enough resources to maintain life. The concomitant problem, in Ponting's (1991) view, is that human societies have had difficulty balancing their "various demands against the ability of ecosystems to withstand the resulting pressures." Countries that employ intensive agricultural systems have met the needs and many of the wants of their citizens, a high value; but, in the view of many, they have made excessive, unsustainable demands on the ecosystem, which was less valued. We in the West use this story of success (Sidey, 1998) in meeting human needs to support our belief in the universal relevance and applicability of intensive agriculture.

Huntington (1996) proposes that "this belief is expressed both descriptively and normatively." Descriptively agriculturalists believe that all societies want to adopt Western agricultural techniques to increase production. We also believe that others are willing to accept Western institutions and practices to achieve these good ends. If they seem "not to have that desire and to be committed to their own traditional values, they are victims of a 'false consciousness' " (e.g., failure to adopt genetically modified seed). Normatively the Western agriculturalist proposes that all societies ought to adopt our methods, institutions and the associated values, because they embody "the highest most enlightened, most liberal, most rational, most modern, and most civilized thinking of humankind." Huntington (1996) says that belief in the universality of Western values and culture suffers from three problems: "it is false, it is immoral, and it is dangerous." In looking at other cultures through our Western lenses and with our Western assumptions about what is good, we make the further error of assuming we are learning about what other people's conceptions of the world are rather than observing how the world really is. Only we understand how the world really is and therefore, we assume we know, how agriculture ought to be practiced. Thus, part of expanding agriculture's moral scope will be to give up some of our hubris about the moral correctness and value of our culture and its agriculture.

Bottom Line Thinking

Goldschmidt's (1998) work claims that the singular goal of our agricultural system was "to gain wealth, without the least concern for the welfare of those whose lives" were being destroyed. There was little thought about the effects of the money-driven system on the environment. The social rewards of belonging to a caring community, the spiritual satisfaction of serving a larger public purpose, and the communities themselves and the businesses that they need and support

were sacrificed to the bottom line (Goldschmidt, 1998). Convenience, ready availability, and low cost are not the only things that matter. There are other things that are important such as the presence of local businesses, friendliness, service, the essentiality of business to any community's survival, and local employment opportunities, and if large-scale farming eliminates or harms these things, then we should think again about the importance of the bottom line. The losses Goldschmidt (1998) speaks of are the social costs of agriculture's technological changes. In agriculture, bottom line thinking is the norm and may be part of the hubris we must reconsider if we are serious about our communities, and our agriculture.

Sustainability

As we reconsider our hubris and the bottom line there will inevitably be conflicting interests that arise from opposing world views, incompatible analyses based on different views of the nature of the problem, rising material expectations, and different views of sustainability (Allen, 1993). Few oppose sustainability but there are many different views of what ought to be sustained. Expanding agriculture's moral scope requires that we give up the common two-track agricultural defense used when issues ranging from pesticides to sustainability and loss of small farms to animal treatment are raised. The first track has been to deny that the suggested problem exists (e.g., pesticides don't harm people or wildlife, people who use them incorrectly do), and the loss of small farms is unfortunate but it is an economic not an agricultural matter. The second defense has been to explain, calmly, but forcefully, that the reforms advocated (e.g., reductions in pesticide use, maintenance of small farms, humane animal treatment) will make food too expensive and diminish or eliminate the favorable balance of trade the U.S. enjoys from its agricultural surplus. The argument claims that the public will not tolerate higher food costs to save a few small, inefficient farms; the reforms would surely diminish or eliminate the trade surplus, and neither is politically acceptable.

Expanding agriculture's moral scope demands considering challenging views of agricultural practice. For example, Ludwig et al. (1993) posit a "remarkable consistency in the history of resource exploitation: resources are inevitably over exploited, often to the point of collapse or extinction." The view is shared by Ponting (1991), Berry (1977), Jackson (1980), and other commentators on modern agriculture. Ludwig et al. (1993) suggest that wealth or the prospect of wealth generates social and political power that is used to promote unlimited exploitation of a resource. Exploitation of land and farm communities are good examples. Scientific understanding is hampered by lack of controls, and the natural variability that is expressed on a large scale so detection of effects is very difficult. The complexity of large agricultural systems encourages a reductionist approach to study and management that precludes observation of large-scale

effects. In the view of Ludwig et al. (1993) the long-term outcome is a heavily subsidized industry that overharvests the resource. That seems to be a perfect description of modern agricultural practice. Ludwig et al. (1993) suggest that sustainable exploitation is always preceded by over exploitation. If they are correct then agricultural sustainability will not be achieved by adjustments to the present system. Experience over 3000 years, as documented by Ponting (1991) and cited by Ludwig et al. (1993), suggests that good scientific understanding of exploitation, its causes, and the appropriate prophylactic measures are not sufficient to prevent destruction of the vital resource. It is a sobering commentary that must be considered and addressed by the agricultural community and the larger society in the quest for sustainability.

Kirschenmann and Youngberg (1997) understand the complexity of agriculture's striving for sustainability. They acknowledge that those involved in the discussion must consider biotechnology, continuing agricultural industrialization, public concern about food quality and safety, pesticide use and abuse, rural community deterioration, worker welfare, international trade, global competitiveness, farmland preservation, wildlife and habitat protection, public funding of agricultural research and extension programs, natural resource conservation, and how to identify and somehow include what have been external agricultural costs. None of these is a simple issue. Kirschenmann and Youngberg (1997) believe agriculture will develop along two paths. The first will be "larger, highly specialized, vertically integrated farms" with efficient input management and precision farming techniques. The second will be "small, intensively-managed, diversified operations" with low input and an emphasis on sustainability. Many of the latter will emphasize organic production methods (also see den Hond et al., 1999). The two paths are not necessarily heading in opposite directions and should not be viewed as conflicting agricultural futures. Kirschenmann and Youngberg (1997) forecast that biotechnology will be the primary force that shapes tomorrow's agriculture, and that water quality will be the major environmental issue. There will be increased reliance on export markets to sustain grower profitability while the primary concern of consumers will be food safety. There will be a resurgence of rural communities near cities but a continued, slow demise of isolated rural communities. Development of sustainable agriculture will be emphasized, but there will be a decreasing level of public support for agricultural research in publicly supported agricultural institutions.

CONCLUSION

Agricultural scientists share with other scientists a passion for the truth. We hold the Socratic belief that the search for the truth is the very best way of life (Melchert, 1995, p. 452). We err when we engage in distorting the truth by hiding it from ourselves or pretending that it is other than what we know it is. We tend

toward that mistake when we think that what has no price has no value, that what cannot be sold is not real, and that the only way to make something actual is to place it on the market (Merton, 1960). Merton tells us that bottom-line thinking cannot answer all questions. Small-scale farmers may be necessary to care for the land, our most precious resource; small communities may be important to our national and personal character. Neither is susceptible to pure economic analysis. Merton (1960) also deplores in strong, environmentally oriented language "constructing a world outside the world, against the world, a world of mechanical fictions which contemn nature and seek only to use it up, thus preventing it from renewing itself and man." Strong environmental criticism is not foreign to agriculture but it is not valued as a means to seek the truth about agriculture.

As agriculture searches for an ethical standard while being compelled to deal with criticism of its apparent bottom line standard, and the environmental problems that have followed modern agricultural practices, one must ask, as Holt (1997) has, "how do we find our way?" Holt's answer comes in the context of his concern that "if there are no revealed truths, immutable principles, or even practical, utilitarian generalities, such as the importance of honesty and integrity, that apply to science, how can we determine what constitutes ethical behavior?" When there are no points of reference, no moral certainty, in what he sees as "a sea of uncertainty," how can one make ethical judgments? Holt's answer epitomizes bottom line thinking and is apparently utilitarian. He argues that in the global marketplace of which agriculture is now a part, "the question of whether it is ethical to conduct research on certain subjects, including products or services that might do harm to the environment or make food unsafe (e.g., chemicals), is moot. The need for effective pest control will be so great that no options can be precluded before research reveals the potentials." He goes on to suggest that research on technology that might cause dislocations (a locution that avoids the unpleasant connotation of suffering) of small farmers is also moot. Market oriented economies and diminished government interference in agriculture will "assure that less efficient and productive practitioners will be dislocated." Holt's (1997) concluding message for agricultural scientists is quoted in full below.

> I think there is an important message for agronomists and other agricultural researchers and research administrators in this analysis of driving forces. It says that as you plan and implement research on the environment, natural resources, safety, social issues, or other themes, keep it within the context of quality, productivity, and efficiency. In order for any technology or information generated in that research to find fruition in practice, it will have to contribute to quality, productivity, or efficiency or at least not detract from them.

Holt (1997) believes that the "broadly focused ethical debates of the past" are also moot. His view is consistent with Day's (1978) view that agriculture has

only one proper goal—profitable production. This view ignores the necessity of balancing the often conflicting goals of profitable production and environmental quality or the loss of small farms and the rise of corporate agriculture. Agriculture's continuing problems with and concerns about pollution from pesticides and nitrates, animal welfare, soil erosion, loss of genetic diversity, genetic modification of plants and animals, and food safety are all swept under the carpet of profitable production that makes all other arguments moot. To be moot is first to be open to discussion or debate, to be debatable, and second to be so hypothetical as to be meaningless. It is the latter definition that Holt (1997) uses, and I fear it is the view shared by most in agriculture. It is a view that says "we are doing the most ethical thing of all, feeding the world and when you are hungry you will recognize the wisdom and rightness of our actions and methods." The view dismisses the cries for justice, environmental quality, or food safety as pusillanimous appeals that are moot.

In Holt's (1997) view there is no compelling moral argument for saving family farms because of the economic realities of the global market within which agriculture must operate. Wendell Berry (1977) and others who argue for preservation of family farms, on the basis of a Jeffersonian agrarian appeal about the virtue of the small farm and how it was and remains the basis of our civilization obviously, from Holt's perspective, just don't understand the modern world.

I conclude that while agricultural scientists are ethical in the conduct of their science (they don't cheat, don't fake the data, give proper credit, etc.) and in their personal lives (they earn their wages, take care of family, respect others, are responsible for their actions, etc.), they do not extend ethics into their work at a deeper level. Agricultural scientists are the reluctant revolutionaries that Ruttan (1997) identified, but they are also realists. Realists run agricultural research and the world; idealists like Berry and Jackson do not. Idealists attend academic conferences and write thoughtful articles and books from the sidelines (Kaplan, 1999). The action is elsewhere. The rule is, produce profitably or perish in the real agricultural world. Realism rules, and philosophical and ethical correctness are no more necessary for useful work in science than theological correctness is in religion (Rorty, 1999).

I find that true, but I want more. I want my agricultural colleagues to accept the burden of beginning the difficult task of doing a discriminating cultural and moral analysis of agriculture and its results. We must strive for a careful analysis of what it is about our agriculture and our society that thwarts or limits our aspirations and needs modification. That analysis must include the U.S. Department of Agriculture, agricultural colleges, scientific societies, and the many commercial organizations, which serve and profit from agriculture. Those features that are beneficial must be nourished and strengthened and those that are not must be changed. To fit ourselves for this task, we must be sufficiently confident to study ourselves and our institutions and dedicated to the task of modifying both. It takes a combination of intellectual rigor and management skill to do this well.

Management skill is required but difficult to achieve. Intellectual rigor annoys people because it interferes with the pleasure they derive from allowing their wishes to be the father of their thoughts (Will, 1999). Most people don't want their assumptions challenged, they want to use them.

To preserve what is best about modern agriculture and to identify and oppose the abuses that modern technology has wrought on our land, our people and other creatures, and finally to begin to correct them will require many lifetimes of work (Berry, 1999). Agriculturalists must try to see agriculture in its many guises—productive, scientific, environmental, economic, social, political, and moral. It is no longer sufficient to justify all agricultural activities on the basis of increased production. Other criteria, many with a clear ethical foundation, must be included. Citizens of the world's developed countries live in a post-industrial, information age society, but they do not, and no one ever will, live in a post-agricultural society. Societies have an agricultural foundation within their borders or in other countries. Those in agriculture must strive to assure all that the foundation is secure.

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CHAPTER 6

The Relevance of Ethics to Agriculture and Weed Science

> *"Agriculture experts" and "agribusinessmen" are free to believe that their system works because they have accepted a convention which makes "external" and therefore irrelevant, all evidence that it does not work. External questions are not asked or not heard, much less answered.*
>
> W. Berry, 1977. The Unsettling of America: Culture and Agriculture. Avon Books, P. 172

> *Like it or not, ready or not, the age of agricultural ethics has arrived.*
>
> Ferré, 1994

After describing a few relevant moral theories (see Chapter 4) and suggesting that those in agriculture possess abundant, but perhaps inappropriate, moral confidence (see Chapter 5), it is time to take up the task suggested toward the end of Chapter 3. That task is to demonstrate that underlying views on agricultural issues is an ethical foundation that determines agriculture's ethical horizon. Knowing that foundation for any position, it was suggested, is an important step toward resolving any of agriculture's ethical dilemmas. The question is can one show how ethics and ethical theory can be applied to weed science, a small segment of agriculture? If such a connection can be made it should be easy to extrapolate the connection to agriculture's many other sub-disciplines. Earlier the text claimed that scientific objectivity should include thought about what value judgments are made, might be made, and perhaps ought to be made by scientists in any discipline. That claim included the assumption that an ethical foundation underlies views on important agricultural issues and that the ethical position is often unexamined and may even be unknown. In this chapter I ask if such claims have any validity when applied to one of agriculture's sub-disciplines: weed science.

I selected weed science as a test case, because I know it best and because it represents much that is good and bad about agriculture. Weed science and, by

implication, all agricultural disciplines, is deficient[1] because its implicit values are unexamined and its operative values are purely instrumental (i.e., they are purely means to an end).

HIGHLIGHT 6.1

In his small book—*Too Many People*, Grant (2000, p. 7) presents a challenging calculation. Using the World Bank's data for 2000 (World Development Report 2002), Grant asks, "How many people could live at a decent level at present rates of economic activity?" His calculation begins with the average per capita GNP of the World Bank's 53 high income countries (there were 44 when Grant made his calculation in 2000), which he uses as "a crude surrogate for a good standard of living." He then assumes that the current world GNP is environmentally sustainable, which is not the same as assuming it will not grow. A simple division follows:

$$\frac{\text{World GNP in US \$}}{\text{Average GNP of 53 UN High Income Countries}} \quad \frac{\$31{,}171 \times 10^9}{\$24{,}781 \text{ per capita}} = 1.26 \times 10^9 \text{ people}$$

The logical, and expected, conclusion is that only 1.26 billion people can be supported by the earth at "a decent level." The earth now has somewhere over 6,442,285,321 people (www.census.gov/main/www/popclock on May 18, 2005 @ 20:09 GMT). Grant assumes a "decent level" is the standard of living in the world's industrial countries. Following Grant's logical calculation, one may conclude: 1) Grant is wrong, 2) The poor must get poorer, or 3) The rich may remain rich, but will feel more threatened.

The UN/FAO estimates the world now has as many as 850 million people who are undernourished. The number of undernourished declined in the first half of the 1900s but is rising again. And, while the earth remains productive, it is taxed heavily (Clayton, 2005).

More land has been converted to crop land since 1945 than in the previous two centuries combined. Crop land now covers one-fourth of the earth's surface and not much more land is available for expansion.

About 20% of the earth's coral reefs were lost and another 20% degraded in the last few decades.

The amount of fresh water stored behind dams has quadrupled since 1985, agricultural use has exceeded long-term supplies by 5 to 25%.

[1] Much of this chapter is a revision of Zimdahl, R. L. 1998. Ethics in weed science. *Weed Sci. 46*:636–639. Reprinted with permission.

Farmers' increased use of nitrogen fertilizer since 1985 has polluted waterways and coastal ecosystems. About 35% of coastal mangrove swamps that serve as biological filters have been bulldozed.

Ocean fisheries are nearly all over-fished, with stocks down 90 to 99% from pre-industrial levels.

Ecology teaches that all systems are inter-related and inter-dependent. No one is sure if a butterfly's flight in central China will cause a storm in Iowa (or vice-versa), but the metaphor illustrates the potential inter-relation of all things. During the next 50 years, the final period of major agricultural expansion, demand for food by an expanding population, and especially by the citizens of the UN's high income countries, will be a major driver of global climate change (Tilman et al., 2001). If past trends continue, Tilman et al. (2001) predict that another billion hectares (2.47 billion acres) will be converted to agriculture by 2050. Humans already release as much nitrogen and phosphorus to natural ecosystems as all other sources combined, and releases will increase. Pesticide use will increase, with all of its attendant problems. Tilman et al. (2001) project what is likely to happen, Grant (2000) asks if all can be fed at a decent level. Few in agriculture are asking the moral question: Should any of this be allowed to happen? Is this what we, in agriculture, ought to be part of?

We may need what Conway (1997) calls a Doubly Green Revolution. But somehow it must include the moral questions of what is right for humans and for the earth and its other creatures. Agriculture is the single largest human interaction with the environment. Its conduct demands it be so. A doubly green revolution must prevent continuing environmental damage, as outlined above, and try to feed all. It is a huge scientific and ethical challenge. Perhaps the largest ever.

There is no question that the agricultural system of developed nations is enormously productive. Production of most crops are produced each year with fewer producers and food costs less. That accurate claim is one that any manufacturer would be proud to make. But those enormously productive technologies always have undesirable ecological effects. The doubly green revolution needs new technology that may not yet be readily available. Biotechnology (see Chapter 8) may do it, but not quite yet. Organic agriculture holds promise but with present technology and production levels, it cannot feed the world of today no less the 50% increase that many forecast by 2050.

We need to produce. We need to think about our life style and that of others. We need to explore whether agriculture must stay industrially based or if it can move to an environmentally sensitive system(s) where biology and ecology rather than chemistry become the foundation.

Agricultural scientists tend to view the values of groups (e.g., farmers, environmentalists) or populations (e.g., Americans) as aids or obstacles to improving the productivity and profitability of agriculture: the primary values. Other values are subordinate to the primary goals of production and profit, which are uncritically assumed to be good. This chapter suggests that the primacy of these values should be debated, because production and profitability are but instrumental goals. They are the means to meet human needs. As operative values are discussed, we should consider broadening the concept of productivity and efficiency to include basic environmental, resource, ecological, health, social, and political processes and the costs and benefits of agricultural technology (Dahlberg, 1982). The ultimate formulation of a sustaining ethic for weed science will not be as difficult as all of these criteria imply, if the ethic can be based on a value all might accept, such as meeting human needs (Burkhardt, 1986). Innovation in agriculture can be good, but perhaps it will be best when what agricultural scientists declare good is also judged good by a concerned populace that finds agricultural innovations compatible with their view of what constitutes the good life, the good society, and satisfaction of human needs.

As stated before, agriculture is the most significant and widespread human environmental interaction. Therefore, public participation in decisions about the effects of agricultural technology is inevitable. Public debate about values and the governing ethic should precede actions that we presume will lead to meeting human needs. Industrial weed scientists who design strategies to induce change in weed control techniques, and university and public sector scientists who study and test components of these strategies, must be willing to submit their assumptions about what is good and the reasons for these assumptions to public scrutiny.

It is not my intent to describe all aspects of an ethic for weed science. That is this chapter will not describe what ought to be done to solve different ethical dilemmas in weed science and then give the supporting reasons for action. I do not know the precise characteristics of the discipline's ethical foundation, and it would be arrogant even to suggest I do. I am certain the characteristics of acceptable values and the supporting ethical theory must be considered.

As weed scientists plan their course, they must ask what is good, who benefits, who is harmed, what is not considered, what are the externalities. I know I cannot and should not attempt to answer such questions for all weed scientists. I suggest exploration, a chance to see other views. Thus, the purpose of this chapter is to explore the elements of an acceptable ethic for weed science.

Science is a descriptive, explanatory enterprise, whereas ethics is normative (that which establishes norms or standards) and prescriptive (that which prescribes what ought to be done). Ethical debate elicits reasons for what we do and ought to do. In contrast to science, ethics does not rely on an established body of factual knowledge or presuppose and rely on a set of fundamental scientific laws. Much of science proceeds via the scientific method aided by occasional bursts of inspiration, but most ethical analysis does not follow the same predetermined method.

It is my perception that ethics and exploration of values are regarded with suspicion by many because it is assumed that bringing up the subject of ethics or values implies the need for not just change, but reform. It implies that something is wrong and that those who are ethical (or who can at least use the jargon) are going to prescribe what is right, what ought to be done. There is a deeper reason for suspicion of ethics. Agricultural scientists think of themselves as having "an abundance, even an excess, of concern" for agriculture and society (Dundon, 1986). Agricultural scientists (including weed scientists) know their work is founded on the most ethical behavior of all: feeding the world. How can that be questioned? One suspects that those who raise ethical questions about agriculture have never understood its purpose. It is also clear that weed scientists share with other agricultural scientists a deep commitment to the value of "persons, institutions, and ways of serving both" (Dundon, 1986). Questioning the nature or depth of that commitment by outsiders is looked upon as meddling with deep-seated, essential values. Some meddlers may be regarded as kooks and colleagues may be regarded as traitors. And the meddler who questions current practice and fails to put in place a new practice that the agricultural scientist can add to the field's competency is subverting the fundamental responsibility and competency of the profession, while bringing harm to its future (Dundon, 1986).

Value analysis is inherently a subversive undertaking that is likely to have the short-term effect of converting certainties into problems. Achieving value consensus is a meaningful, useful ideal when it enables scientists to proceed beyond analysis of values to a statement of institutional preference for particular values (Bressler, 1978). It would be good to include a statement of corporate value preference in any agricultural society's mission statement. The American Society of Agronomy and the Crop Science Society of America have had statements of ethics since 1992. The Soil Science Society of America adopted a statement in 1999 (www.agronomy.org/ethics, www.crops.org/ethics, www.soils.org/ethics—Accessed March 2004). The Weed Science Society of America has no similar statement.

Scientists learn that the scientist *qua* scientist cannot (should not) make value judgments and that knowledge is confirmed by statements in texts used in science courses. Value judgments are, at worst, the purview of politicians and, at best, of society in general (Rollin, 1996). Rollin (1995) suggests that when any discipline finds itself in a position where there is no value consensus, and clarification and discussion are required, "the most shrill and dramatic articulations and discussions of such issues will tend to seize the center stage." Rollin (1995) calls this Gresham's law of ethics, which argues that in the absence of informed expertise to counter and moderate shrill, dominating distortions, the distortions "will dominate the social mind and drive the legitimate ethical concerns out of awareness." I think this is the situation in which weed science and, by implication, all of agriculture, finds itself. Agricultural scientists have allowed the shrill

voices, a few internal and most external, to dominate public perception of who we are, what we do, and why we do it. Weed scientists have heard, and I suspect many believe, that the best offense is a good defense. But weed science has not had an offense; it has had only a defense against external distortions of its technology. A good offense must begin with an understanding of the ethical foundation, followed by discussion of the implicit values of the discipline and a statement of consensus on its values.

Day (1978) laid out one view of the best ethical foundation for all of agriculture in his presidential address to the American Society of Agronomy. He proposed that the basic and only morally defensible foundation for agronomy was to produce food and fiber. I have suggested that production is currently the dominant ethic for weed science and all of agricultural science (Zimdahl, 1998). Those who subscribe to this ethic usually recognize that its results have not been universally applauded, but they often fail to see that the lack of applause has been for good reasons. These reasons include valid objections from five perspectives (Danbom, 1997). The first perspective includes socially conscious individuals and organizations who suggest that production has been achieved at the expense of the environment and our natural resource base. Second are modern agrarians (e.g., Wendell Berry), who note the loss of family and community values and the rise of selfishness and materialism that often accompany increased production. The third perspective includes those who warn of the unsustainability of modern production practices. Still others warn that our abundance has been accompanied by deterioration, or at least a perception of deterioration, in food quality and healthfulness. Finally, there are those who argue that abundance has been obtained without regard for effects on small farmers, tenant farmers, and the rural and urban poor who have paid a disproportionate share of the price of our bounty. Advocates of these views tend to agree that the high productivity of modern agriculture has been achieved by extensive use of technologies that often contribute to depletion of a nonrenewable resource base (e.g., soil and water). They suggest that the undeniable success of modern agriculture has been achieved by combining mechanization, genetic manipulation, and chemicals and that it is dependent on a massive, unsustainable fuel subsidy (Pais, 1982).

What is right about the production ethic, and there is much right about it, is that it allows about 2 million Americans to feed the rest of the population of the U.S. One U.S. farmer now feeds about 130 people in the U.S. and abroad, whereas in 1960, one farmer fed only 26 people. U.S. farmers produce 43% of the world's soybeans and 34% of the world's corn.[2] Weed scientists take pride in and correctly claim credit for their contributions to this productivity. Their work has played a prominent role in increasing the world's food supply and decreasing the labor of weeding crops. They believe they have made significant contri-

[2] Data are from The Agricultural Council of America, 11020 King Street, Suite 205, Overland Park, KS 66210.

butions to increasing local, national, and international food supplies. What is wrong with the assumed primacy of Day's (1978) production ethic is that it centered on the interests and rights of some humans while ignoring the rights and good of other living things (Comstock, 1995). It has created a system that ignores Liberty Hyde Bailey's (1915) admonition that "a good part of agriculture is to learn how to adapt one's work to nature."

This chapter began with the premises that agricultural and weed science lack a well constructed, carefully articulated ethic and that values are treated only instrumentally. It concludes by suggesting some components of an acceptable ethic for agriculture and weed science.

Ethics were not part of what I was taught during my formal education, and consideration of the ethical aspects of my work has not been a regular part of my collegial or professional discourse. If my experience is typical, and I think it is, then a dispassionate observer might conclude that weed scientists have not thought about the ethics of their science or the particular set of values that have driven its development. This view was affirmed several years ago when I met with several weed science colleagues during scientific meetings to begin exploration of some value questions. At the beginning of the interview, I asked several background questions (Where were you born? What did your parents do? Where did you obtain your degrees? etc.). About half way through the one-hour interview, I asked "What values have driven your weed science career?" The first response to the question was a blank stare. To illustrate the question's intent, I offered a brief commentary about the importance of honesty in science. The answer subsequently received, in every conversation, was nearly identical: honesty in scientific work and never manipulating the data. This was followed by the value of earning one's pay, working hard, caring for family, caring for children, being a good neighbor, being a good citizen, being responsible for actions, and being trustworthy. Not everyone interviewed gave exactly the same answers or used precisely the same words but each explained the values that had driven their career as a list of the characteristics that define a good person. No one questioned the value of agricultural production or its primacy in agricultural endeavors. No one questioned why greater production always was a higher value than environmental protection. No one questioned the value of increasing use of herbicides versus possible harm to non-target species or humans. Everyone was and wanted to be ethically correct in their personal lives but did not transfer any degree of ethical concern to their work except to agree that one must follow the scientific rules.

I have argued (Zimdahl, 1998) that weed scientists define a good agriculture as one that optimizes yield and maximizes profit. I knew I worked in an agricultural system that was driven by government programs that had the unintended effect of bestowing the greatest benefits on the largest farmers and encouraged oversupply of commodities and low prices to farmers. It was also a system that always kept supermarkets full of an abundant variety of food. Agriculture's

problems were confounded by a production system that encouraged widespread use of agricultural chemicals and intensive mechanization that, when combined with the effects of government programs, discouraged diversification and crop rotation while encouraging monoculture. Unintended but real effects included farm consolidation, loss of rural communities and businesses, and much of what our society values about rural America (Danbom, 1997).[3] Our agricultural production system had led to agriculture being viewed as a source of problems by the public rather than as a public good (Kirschenmann, 2000).[4] Not all of agriculture's effects are positive (e.g., ecological degradation, loss of rural communities) and each involves ethical questions. I am compelled to acknowledge and deal with the observation that much of what is involved in modern American agricultural production may cause ecological deterioration and loss of biological diversity and also that it may impair human health. These things never appear in conventional financial balance sheets, and we therefore gain the false impression of untroubled and unending wealth and success (Ehrlich & Ehrlich, 1990). The dominant tendency in American agriculture is to judge the success of any technology or the whole enterprise solely with economic criteria (Kirschenmann, 2000)[4]. If it is not profitable it must not be valuable. Agriculture's producers and scientists have been lulled into the false productionist belief, according to Thompson (1995, see Chapter 3), that the proper goal is to produce as much as possible regardless of the cost. The view is that measuring agriculture's success in terms of production of food and fiber is both a necessary and sufficient criterion for evaluating agriculture's ethics (Thompson, 1995, p. 48). We may know but tend to forget that "ecological criteria of sustainability, like ethical criteria of justice, are not served by markets" (Daly, 1996, p. 22) and their requisite economic criteria for success.

These observations describe a view of what American agriculture is. The question we need to ask is what weed science, an important part of American agriculture, ought to be. If we fail to understand the importance of beginning the discussion and striving for agreement on what we ought to do and be, we will only add, as Freudenberger (1994) suggests, momentum to the pace of human and natural resource depletion.

The utilitarian approach we have embraced, individually and collectively, albeit unknowingly, is not to be discarded. It is not all wrong. The basic ethical words for a utilitarian are "good" and "bad." The problem, outlined above, with the common agricultural version of utilitarianism is its singular emphasis on production as the only, or at least the best, way to achieve the greatest good for the greatest number. I suspect the best ethical foundation for weed science will

[3] For a good explanation of the things valued see Thompson, P. 1997. Agrarian values: Their future in U.S. agriculture. Pages 17–30 in W. Lockeretz, ed. Visions of American Agriculture. Iowa State University Press. Ames, IA.

[4] The W. O. Eddy lecture presented at Colorado State University, September 28, 2000. Unpublished.

combine a utilitarian base with some of the best elements of a rights-based ethic (Comstock, 1995). In a rights-based ethic, the basic words are "right" and "wrong." One criterion for judging whether something is right or wrong is to determine the effect of the action on others. An act's correctness, rights theorists hold, is also to be judged by its compatibility with justice and the rights of all concerned. For me, the weed scientist's concern must be expanded to all humans, other species, and the environment. In the utilitarian view, good consequences make an action right, and bad ones make it wrong. Increasing food production is good, but this good may lose its primacy when it is affected and modified by including considerations of the rights of others and the need for justice for all. Production growth may be reaching the point where its environmental and social costs are increasing faster than its economic and human benefits (Daly, 1996, p. 151).

I suggest agricultural and weed scientists examine their science in the context of its applications and the values that it enhances. We could begin by struggling with the options for future directions that Kirschenmann (1993) offers. The first option is to stay the present course without knowing how long it will be possible. Secondly, weed scientists could emphasize a search for technological fixes such as another herbicide when resistance appears. These and similar agricultural technological fixes will adjust or modify, but probably not solve, problems that are now so apparent. Finally, he suggests we try to consider how science will contribute to regenerative food systems that will certainly include technology but are not dependent on a series of technological fixes. Kirschenmann (1993) elects the third option and thinks it means agricultural science must become part of a caring culture. For him, that is a culture governed by making explicit that healthy prospects for future generations and a healthy landscape are paramount values. They can be part of the ethical foundation upon which we stand.

Scientists learn subtly, almost by osmosis, through their education and experience that the scientific process tends to disregard the subjective role of humans in the construction of reality (Conviser, 1982) and that scientists are often not fully cognizant of the political economy that shapes production of knowledge. Science, as we have learned, doesn't make value judgments! Wendell Berry (1977) has offered two views of the construction of agriculture's reality: exploiter vs. nurturer. Berry asked his readers to consider which of the two views best described the values agriculture ought to advance. I suggest Berry's characterization of the exploiter vs. the nurturer poses questions that agricultural scientists should consider as they debate appropriate ethical norms. I have learned and taught that most simple, dichotomous divisions, if not wrong, are suspect, but nevertheless are often useful for framing discussion. Berry (1977) chose eight ways to compare the two views (Table 6.1). My experience in weed science and among agricultural colleagues has affirmed that although the title may be vigorously denied, the results of our research and how we approach what we do affirms that we have been exploiters, not nurturers. We have been specialists whose major

TABLE 6.1 Two world views (Berry, 1977)

Comparative Term	View of	
	Exploiter	Nurturer
Focus	Specialist	Generalist
Standard	Efficiency	Care
Goal	Money—profit	Health
Concern	Productive capacity	Carrying capacity
Work	Little	Well
Competence	Organization	Order
Serves	Institution	Place
Thinking	Quantitative	Qualitative

(often the sole) interest has been in efficient, profitable production. Generalists who emphasize environmental health and carrying capacity can be found but they are rare. I do not suggest that Berry's comparison is the only way to discuss agriculture's future. It is a certainty that many colleagues will vigorously disagree with how I have characterized the way they practice their science. However, considering Berry's contrasts will help focus the discussion and lead toward development of that which Ferré (1994) says we must have: an ethical foundation for agricultural science.

I close by asking the reader to consider the value of these simple words to the discussion: "The ultimate goal of farming is not the perfection of crops, but the cultivation and perfection of human beings" (Fukuoka, 1978). I find this to be a place to begin, a place that may help us learn, without risk of embarrassment, how to ask about what we need to know.

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CHAPTER 7

Agricultural Sustainability

Live as if you are going to die tomorrow, but farm as if you are going to live forever.

19th Century English motto
Cited by Mepham (1998)

One does not have to probe much of the current writing on agriculture to discover that achieving sustainability of agricultural practices has obtained the generally revered status of motherhood (see Chapter 1), with one important difference. Nearly everyone is in favor of motherhood and there is little debate about its nature. Sustainability is similar in that everyone seems to favor its achievement. The difference is that in spite of the nearly universal adulation of sustainability, there is little agreement on its nature, on what is to be sustained and how it is to be accomplished in agriculture. Pretty (1995) noted that there are at least 80 definitions. Wackernagel and Rees (1996, p. 36) confirm this with their ecological claim that "conflicting interests, opposing world views, incompatible analyses, rising material expectations, and fear of change, have led to a disorienting array of interpretations of sustainability and how to achieve it." The U.S. Department of Agriculture Sustainable Agriculture Research and Education (SARE)[1] program suggests the three primary goals of sustainable agriculture are:

1. Providing a more profitable farm income
2. Promoting environmental stewardship, including:
   —Protecting and improving soil quality
   —Reducing dependence on non-renewable resources, such as fuel and synthetic fertilizers and pesticides, and
   —Minimizing adverse impacts on safety, wildlife, water quality and other environmental resources
3. Promoting stable, prosperous farm families and communities

[1] The goals can be found in an undated brochure—Exploring Sustainability in Agriculture, produced by the SARE program. See www.sare.org

Douglass (1984) described three primary uses of sustainability as they had appeared in the literature. It could mean some or all of these three things:

a. Sustainability of production. Long-term food sufficiency, either domestic or worldwide. The practice of agriculture is the way the world is fed and economic cost-benefit analysis of agricultural science and technology is how one determines the best way to practice agriculture to sustain it and thus prevent massive starvation.
b. Sustainability as stewardship. A primary concern for ecological balance and environmental quality. The proper quest is to create an agricultural system that preserves and conserves renewable resources while not polluting the environment or disrupting ecological balance on which life depends. Achieving sustainability is not a production question. It is a matter of knowing the ecological consequences of any production system and then minimizing the negative consequences. In Westra's (1998, p. 175) words, in regard to the earth's natural systems, sustainability means maintaining "optimum, undiminished capacity for their time and location for sustained evolutionary development."
c. Sustainability as community. Sustainability is achieved by creating a set of agricultural practices, which encourage certain virtues that undergird the vitality of local communities. It is these practices which are to be preserved or reinstated. This view is similar to the second one, but emphasizes maintaining the "social organization and culture of rural life."

HIGHLIGHT 7.1

"The essence of food and fiber production is that on one hand, the key production resources (seeds, tubers, soil, manures, and rain water) are renewable, thus potentially enabling agriculture to be a highly sustainable activity. On the other hand, agriculture has some actual or potential characteristics of an extractive industry, similar to mining, and accordingly has the potential to be highly unsustainable. In addition, food and fiber production may involve long-term non-environmental costs (e.g., impacts on workers, communities, regions, and consumers) to a greater or lesser degree" (Buttell, 2003).

No one is overtly against achieving a sustainable agriculture. But the concept continues to elicit cautious and some negative reactions from the agricultural community (Schaller, 1993). Agribusiness companies that create and sell products (fertilizer, pesticides, seeds, machines) to farmers and ranchers are concerned that business will decline if there is a rapid shift to low-input agricultural production systems. Many agricultural scientists and producers know that the present system is highly productive of food and fiber and fear that the quest for sustainability will reduce yield and profit. In

Schaller's (1993) words moving away from the present system will be a step backward to the era of low production and surging pest problems. Many scientists and producers also think they have been environmentally and socially responsible and resent what they think is unjust criticism. The production system is not perfect but it is steadily improving and those who create improvements should be given credit, not criticized. Schaller (1993) argues that while concern about the affects of a new system are justified, they often arise because the new system demands a "fundamentally different way of thinking." When one has learned a system, whether it is one of food production or education, one masters the intricacies of that system and the demand to learn a new system is resisted. Learning a new system may involve acknowledging that the old system is part of the problem not the solution. The old system and way of thinking must be, at least, partially abandoned as one develops or learns from an entirely new way of conceiving the problem and its solutions.

These are, respectively, the food sufficiency, stewardship, and alternative agriculture definitions and the requirements to achieve each differ. Prominent questions include whether achieving food sufficiency is possible if population continues to grow, how long modern agriculture's production techniques can be sustained, what can be sustained for how long, and what must be done to achieve sustainability (Burkhardt, 1989) and who benefits, at what cost, and in what place it is to be achieved (Pretty, 1995). Pretty (1995) notes that particular technologies are not sustainable because they change and new ones appear. Therefore, what must be sustained, in his view, is "the process of innovation itself."

It is reasonable to posit that achieving sustainability of any agricultural system is a societal not just an agricultural responsibility, which should be greeted with pleasure by those in agriculture (see Chapter 5), because they don't have to do it alone.

THE PRESENT AGRICULTURAL SITUATION: THE EXAMPLE OF WEED MANAGEMENT

Whenever possible, today's farmers and ranchers take advantage of economies of scale to produce more and earn more profit. Getting big has been good from the economic point of view. Larger units tend to operate more efficiently and cheaply per unit of production than small ones. Costs can be lower because larger size allows one to take advantage of volume discount buying and the efficiency of large planting and harvesting machines. Modern technology can increase productivity of labor and decrease machine operating cost per operating unit and

per acre (Edwards, 1980). Edwards (1980) claims that most modern technology, (e.g., tractors, harvesters, pesticides, new cultivars) has tended to encourage growth in farm size. Commodity pricing favors the large farmers as do most government price support and subsidy programs. To survive and make a reasonable living, farmers are forced to become large because the profit margin on a unit of product is low and declining with time. For example, from 1910 to 1990 the share of agricultural dollars received by farmers dropped from 21 to 5 percent (Standaert, 2003). U.S. census data (see http://www.usda.gov/nass/pubs/trends.htm) for nearly all states support the claim that farms are becoming larger and the number of farmers is declining.

In addition, after more than 100 years of agricultural research by land-grant colleges and agribusiness companies one finds yields of nearly all crops are high in the world's developed countries, the need for human labor is low, and input costs are high. Global per capita calorie availability rose by almost one-third from the 1930s to the late 1980s. Per capita food supplies rose by 40% in Africa, Asia and Latin America (Eberstadt, 1995, p. 8). Modern, developed country agriculture is a chemical, energy, and capital dependent system that produces high yields but the required technology creates persistent environmental problems. But sustainability is elusive. Food is abundant for all but the poor and commodity surpluses are common in developed countries (Stout & Thompson, 1991).

Weed scientists correctly claim that the widespread use of herbicides has been a significant factor in increasing yields of most crops but the claim that the highly productive, chemical and petroleum dependent system is sustainable, are muted at best. For example, it takes as much energy to run U.S. tractors as is contained in the food produced (Clark, 1975). Others respond by arguing that agriculture's task is not to produce energy but to produce food and that is done very well.

For most U.S. crops, 85% of the acreage is treated annually with herbicides for weed control (Gianessi & Sankula, 2003). These authors and many others claim that "without herbicides, hand weeding and cultivation most likely would replace current practices" (i.e., herbicides). They estimate these alternatives would cost more than $14 billion annually or more than double what U.S. growers spend on herbicides plus their application. Gianessi and Sankula (2003) reported on 40 agricultural crops and claimed that for 35, yields without herbicides would be reduced 5 to 67%. They do not claim that herbicides are essential to yield maintenance, but they do claim that their loss would demand much more cultivation and hand weeding to maintain yield. Both of these are expensive and there is no assurance sufficient labor for hand weeding would be available at the required time, thus, yields would decline. More cultivation would also increase soil erosion. Neither option appears sustainable. Gianessi and Sankula (2003) conclude that if herbicide use were eliminated, the yield loss of the 40 crops would be $13.3 billion, which is equivalent to 21% of the national production of the 40 crops. Grower income would decline by $21 billion annually. Other studies, cited by Degregori (2001, p. 89), claim losses as high as 70% if all physical,

biological, and chemical (not just herbicides) pesticides were eliminated (Oerke et al. 1994, p. 750). Knutson et al. (1990) estimated a 32% reduction in U.S. corn production if all pesticides were eliminated and a 53% reduction if no pesticides and no fertilizer were used. Without any chemical use, soybean production would decline 37%. Peanut production would decrease 78% and wheat 38%, with no chemicals at all. Knutson et al. (1990) said that in constant 1989 dollars, consumers would have to spend $228 more per household per year if all pesticide use was eliminated. If the ban were expanded to include fertilizers, household spending would rise by $428 per year. Knutson et al. (1990) projected this as a 12% increase in the weekly food bill for middle-income consumers and a 44% increase for the poor. Pimentel (1992) estimated that losses to pests would be 10% higher if no pesticides were used and losses in some crops could approach 100%. In general, each dollar spent on pesticides returns $4 in saved crops (Pimentel, 1992). Farah (1994) acknowledged losses up to 40% of potential agricultural production due to pests in developing country agriculture but emphasized the adverse effects of pesticides on human health (up to ½ million poisonings each year), environmental health, and the problem of pesticide resistance. Large loss estimates if pesticides are not used are common in the agricultural literature whereas human and environmental health effects are not mentioned as frequently. Lehman (1993, 1997) presents moral arguments for reducing (not eliminating) pesticide use in agriculture.

Most farmers in industrialized countries and an increasing number of farmers in developing countries rely on herbicides to manage weeds. The data cited above support the view of most weed scientists that herbicides are important, if not essential, technology if farmers are to continue to be able to feed the world. Their advantages (see Chapter 3) are well known: low cost, safety, efficacy, selectivity, persistence, energy efficiency, profitability, and yield increases. However the disadvantages are equally well documented and herbicides are indeed a "two-edged sword" (Kudsk & Streibig, 2003). They conclude that "herbicides strongly contribute to sustain and secure yield and are indispensable in modern arable farming." They applaud the continued development of new "chemical hoes" since the 1940s and note that this allowed farmers and weed scientists to regard weed control independently of the whole crop production system. Because weed control was studied independently of the cropping system, weed science became isolated from other agricultural sciences (Kudsk & Streibig, 2003). In their view, reliance on herbicides "resulted in shifts in the weed flora and the selection of herbicide resistant biotypes."

Kudsk and Streibig (2003) do not mention associated ethical dilemmas, but they can be identified. They assume but do not ask if the practices they advocate are sustainable. Their position can be formulated as the invalid syllogism below:

Premise—Present weed management practices will not harm people or the environment.

Premise—Weed management practices that harm people or the environment are wrong.
Conclusion—No present weed management practices are wrong.

A correct and valid formulation of the syllogism is:

Premise—All wrong weed management practices are practices that harm people and/or the environment.
Premise—No present weed management practices are practices that harm people and/or the environment.
Conclusion—Therefore, no present weed management practices are wrong.

Kudsk and Streibig (2003) conclude that present practices (i.e., extensive herbicide use) should be (must be) part of future sustainable agricultural systems. Their argument appears to ignore or dismiss public concern about the profession's (herbicide users, manufacturers, and researchers) violation of acceptable standards of professional ethics—perhaps best formulated as, Do no harm—that led to imposition of "increasingly strict registration requirements in some countries." The political response to public concern about human and non-target species health and the public's general environmental concern led to imposed regulations (laws) that govern the future of weed science. These things seem minor to Kudsk and Streibig (2003), who conclude by observing that "society at large is, however, not aware of the benefits of herbicides, and there is urgent need to optimize their use." Optimization was not defined but its components include developing ways to respond to governmental regulation of herbicides, addressing public concern about pesticide residues in food and water, and minimizing possible adverse environmental effects. They also want to "ensure that herbicides will remain an effective and valuable tool to farmers." Continued herbicide use, in their view, is part of achieving a sustainable agricultural system. Pesticide residues in food and water are real in Kudsk and Streibig's (2003) view but "they do not actually pose a risk to public health but their presence does cause concern." Maintenance of present agricultural practice is to be done simply by education. The public must be shown through education that the negative view of herbicide use in agriculture is wrong.

Their argument is a scientific one based on good data, which demonstrates concentrations are so low that any possible effect is so remote as to be impossible or that there is no evidence that the existing concentrations have been demonstrated to cause any harmful effect to any living organism. However, this accurate scientific response is just that—a scientific response to what are commonly non-scientific, moral questions. Evans (1998, pp. 219–220) states the dilemma clearly. He claims that scientists, including agricultural scientists in all their variety, "see themselves as helping to feed and clothe the rapidly growing human population while cherishing the earth." Yet the public sees agricultural scientists as "destroyers of nature, wastrels of water, eroders of land and genetic

resources, polluters of the environment, and hand maidens of agribusiness." Thus, the public regards agricultural scientists and those who practice agriculture as having violated expected professional ethical norms. Kudsk and Streibig's (2003) argument is similar to that made by many well-intentioned agricultural scientists who, in Evans' (1998) view, "seek technological solutions to problems of social and economic inequity." The view is consistent with the scientist's infatuation with more and better science and technology that will solve the problems science and technology created. The claim is that science and technology are not problems, they are required to provide solutions to all societal problems and are necessary to achieve agricultural sustainability. It is, in a less kind view, continuing to do agriculture and agricultural science in the same way to achieve a sustainable system, but expecting a different outcome from the same methods. This has been called a form of insanity by those who observe such behavior.

As discussed in Chapter 1, appealing to science to solve social and economic problems is a failure to recognize the difference between rational scientific truth and what one is to do because of it and the demands of personal or subjective truth. Questions from the realm of personal truth frequently use empirical data to bolster the claim that the questions are scientifically and ethically legitimate. For example, the World Health Organization estimates that every year 3 million people in the world (mostly poor people in developing countries) suffer from severe pesticide poisoning. In 1990 it was estimated that 220,000 die annually, mostly in the world's developing countries (WHO 1990 cited by Pimentel & Greiner, 1997, p. 52). In 2002 Halweil (2002, p. 72) estimated there were at least 20,000 unintentional human deaths and an additional 200,000 suicides. It is reasonable to conclude that these numbers do not represent all severe poisonings or deaths because most occur among the poor. Hence, many are not reported and the cause of death is not always known. The data also do not include the many unreported cases of people who are temporarily sick or incapacitated after applying or mixing pesticides. Those affected die quietly, far from the news of the day. Such occurrences do not characterize an ethically desirable or a sustainable system.

Acute effects on human health are an immediate public concern. Chronic effects are of increasing concern, especially relative to the possibility that low levels of synthetic organic chemicals in the environment at sensitive stages of fetal development can act as endocrine disruptors that affect the structure and functioning of the mammalian immune system (Repetto & Baliga, 1996; Colburn et al. 1996). Accusations of this kind include empirical and moral questions that ought to be addressed clearly and carefully by the agricultural community, but only defensive rejections of the claims are heard.

Over several decades of pesticide development, each new pesticide has contributed to a general trend of products that are safer to the environment, to the user, and the consumer of treated produce (Major, 1992). New products are more specifically active (i.e., they do one thing very well), cheaper, easier to use, and

compatible with other products and techniques (i.e., suitable for integrated pest management programs). Pesticide formulations have become safer to the user and the environment. Application techniques have improved and off-target spray drift has been reduced. Manufacturers have also developed programs to address surplus pesticide disposal and responsible container disposal or recycling. Taken together, one might expect that these actions and the development of desirable pesticide characteristics and improved application techniques should have led to more public confidence about the manufacture, marketing and use of pesticides (Major, 1997), because each appears to contribute to greater sustainability. Exactly the opposite has happened. The result reflects the view of many—to do more efficiently that which should not be done in the first place is no cause for rejoicing or praise.

Major (1997) concludes that those who recommend and use pesticides must accept the legitimacy of ethical concern, be more open, and become partners in environmental improvement, which, if they are sincere, will often trump increased production. Only then can progress be made toward a sustainable system that retains and even enhances productivity but is also environmentally, socially, economically, and politically acceptable and therefore, sustainable.

Some weed scientists have accepted the multiple challenges of achieving agricultural sustainability. Liebman (2001) writing of the need for ecological approaches to weed management, advocates recognition of the many beneficial roles weeds play in agro-ecosystems. In his view, a broad range of ecological processes can be combined with required and new farming practices "to manage weeds more effectively, while better protecting human health and environment quality." Liebman, similar to Douglass' (1984) view of sustainability as stewardship, claims, in contrast to the claims of advocates of modern chemical, energy, and capital intensive systems, that such systems can increase farm profitability by cost reductions, price premiums, and maintenance of healthy rural communities. In short, his claim is that development of ecologically based systems of weed management will be sustainable over time. These systems will not exclude herbicides but will not rely on them as the first choice for weed management. New weed management systems will be more reliant on ecological processes such as resource competition, allelopathy, herbivory, disease, seed and seedling responses to soil disturbance, and ecological succession. These processes have been known to ecologists for many years, but modern weed management systems ignore them in favor of readily available, effective chemical methods to manage weed populations. Today's chemically based systems of agriculture are not sustainable (Douglass, 1984), although they are highly productive.

Mohler et al. (2001) in the conclusion of the book in which Liebman's work appears, write of weed management in a broader context. They suggest that "by reducing the need for herbicides, ecologically based weed management strategies can help farmers reduce input costs, reduce threats to the environment and human health, and minimize selection for resistant weeds." They specifically

disagree with the conventional agricultural position (see Avery, 1995; Borlaug, 2001; Waggoner, 1994) that it is only possible to protect land for wildlife and feed a burgeoning world population if modern high-yield technology (pesticides, fertilizers, genetic engineering, energy, etc.) is used widely on the best land. Their view is exactly the opposite of the dominant agricultural view that we must subdue and dominate nature (see White, 1967). That view asserts that it is our task (indeed our obligation) to transform and shape nature to fit human needs. Weeds and other pests must be managed (killed) to facilitate the transformation of nature so it will be productive of what humans want and need. Mohler et al. (2001) advocate working with nature rather than against it. In their view, to become sustainable, weed management must become an ecologically based rather than a control based discipline. The natural world is not to be regarded as a mechanical, dead place to be managed by humans for human ends, but as an organic, living place that we can learn from as we try to make it more productive of what we need.

HIGHLIGHT 7.2

> "In the end they will lay their freedom at our feet and say to us,
> Make us your slaves, but feed us."
>
> Dostoevsky, F. The Brothers Karamazov
> Book 5, Chapter 5

The word sustainability was first used in the United Nations World Commission on the Environment and Development Report (The Brundtland report) published in 1987. Their definition was to—"meet the needs of the present without compromising the ability of future generations to meet their own needs." The definition implies a commitment to the future. Present generations should strive to live their lives within available ecological constraints because failing to do so means passing the burden of sacrifice on to other people—our children and grandchildren. Doing this would show little love or respect for our descendants and will be regarded by many as an immoral act.

The quest for sustainability is driven by genuine social concern, that is, we care deeply about our descendants and by two competing philosophical perspectives:

1. Nature has inherent value and sometimes human interest must be sacrificed to ecological or environmental values.
2. Ecological balance is important but only because it has instrumental value for present and future humans.

There is little reason to question if people care about their descendants. Many people regularly make sacrifices for their heirs. There are reasons to question if we care enough for our descendants to change the way we do things.

More critics of developed country agriculture point to the same series of problems:

- Polluted water,
- Depletion of potentially renewable soil, energy, and water supplies,
- Harmful effects on wildlife,
- Dependence on chemicals that create environmental residues,
- Depopulation and loss of rural communities, and
- Concentration of capital and control within agriculture.

These concerns are driven by a growing awareness of ecological interactions. An awareness of the fundamental rule that it is not possible to do just one thing. Citizens are coming to believe that in spite of the benefits to some industries, some large farmers, and land-grant universities, the financial, social, environmental, and health costs of modern agriculture are too high.

While it seems important to many to know who to blame, it is not proper to blame agriculture for all of these ills. Wackernagel and Rees (1996) note that coffee drinkers require 25 square meters of what might have been tropical forest to sustain their consumption. The typical American user of fossil fuel needs 2 to 3 hectares (about 5 to 7.5 acres) of forest somewhere on the planet to absorb CO_2 emissions (and that has not been sufficient given rising atmospheric CO_2 levels). Typical Americans need 4 to 9 hectares (10 to 22 acres) of land somewhere to support their consumer life style. They also note that the American Great Plains are not just out there, somewhere, they are an essential part of the urban ecosystem.

Therefore, one is driven to the conclusion that it is nature's instrumental value that is foremost in the human mind, not its intrinsic value or inherent rights. The evidence is that humans are willing to sacrifice ecological and environmental values to satisfy current wants and perceived needs and thereby risk the satisfaction and perhaps the survival of our descendants.

There is resistance among farmers and research scientists to this move. Mohler et al. (2001) suggest the resistance is due to five factors:

1. The ease and low risk of failure when herbicides are used explains why farmers continue to use them to manage weeds. Farmers have enough uncertainty to gamble with (drought, severe sudden storms, poor markets, etc.) and seek certainty when they can.

2. Aggressive marketing of agrichemicals. In support of this point, Kroma and Flora (2003) describe the greening of pesticide advertising. They demonstrate how agricultural media (i.e., farm magazines, radio, television, etc.) have appropriated current societal values in the imagery that accompanies advertisements of agricultural products, including pesticides. Their work demonstrates how pesticide advertising changed from 1940 to 1990 in response to the U.S. socio-cultural setting. The industry strategically repositioned itself "to sustain market share and corporate profit by co-opting dominant cultural themes at specific historical moments," by appearing to adopt expected professional ethical norms. Simultaneously, the industry advertising avoided or masked environmental and social challenges to pesticide use. Pest and weed management was done by successfully selling farmers new chemical products (Mohler et al. 2001).
3. The externalization of environmental and human health costs. The real costs of environmental pollution, water contamination, non-target species harm, and harm to human health are not borne by the user, the manufacturer, those who approve registration, those who recommend, or those who apply the pesticide. These costs are externalized and borne by society when food is purchased and taxes are paid.
4. The increasing dominance of large-scale, industrial farms. Such farms obtain the economies of scale and savings from labor-saving technologies.
5. Government policies that encourage chemical and energy intensive agricultural practices. Government policies favor use of technology that increases production as opposed to policies that favor integration of production goals with simultaneous achievement of social justice and environmental quality.

Mohler et al. (2001) conclude that achieving an ecologically based sustainable farming system is a task that must be shared by farmers, agricultural research scientists, government policy makers, and a public that demands and supports the change. As mentioned at the beginning of this chapter, it is a public responsibility, not exclusively a task for the farmer. However, as Burkhardt (1989) points out so well, that which is everyone's obligation (a collective, societal obligation) is often no one's obligation individually and little is accomplished.

THE MORAL CASE FOR SUSTAINABILITY

Society is comfortable with ethics preceded by adjectives such as Christian, medical, legal, and more recently environmental. To paraphrase Rolston (1975), the moral noun ethics does not regularly take the scientific adjective agriculture. Ethics and agriculture do not go together easily for two reasons. The first is that

the few philosophers who focus on agriculture are not read widely within the agricultural community and their thoughts have not yet had a major affect on conventional agricultural thought. The second reason is that mentioned in Chapter 1, people engaged in agriculture are sure that food and fiber production are among the most ethical things anyone could do and are not therefore, a proper focus for ethical challenges. However, if agricultural practice is to achieve the desired but elusive virtue of sustainability, the focus must include the good end of food and fiber production and an examination of the means to that end. The individual claim of virtue and ethical correctness because food production, a worthy goal, a good thing that should be applauded, must be tempered by a collective view of what is good for all. Here, by all, I mean all creatures and the environment that supports them. Producing food and fiber are good things. Feeding people is a good thing. But, these are not the only good things that must be considered as we try to achieve sustainable agricultural systems. There is no question that such systems are required. Pests are not going to disappear and it will be impossible to produce adequate food and fiber without effective pest management.

Thompson (1995, p. 15) claims that "agriculture cannot continue indefinitely without an environmental ethic, or at least it cannot continue happily." This means to me that all agricultural practitioners, including pest control scientists, need to develop a supporting ethical foundation. An environmental ethic must become part of the ethical stance of agriculture and that will not create but will lead toward a sustainable system. Creating that ethic will compel review of the adverse consequences of modern agriculture and that review may lead toward development of a universal agricultural/environmental ethic. Agricultural scientists from all disciplines may become that which they have disparaged—environmentalists.

But why must we bother? In a pure utilitarian calculus, the adverse consequences of agriculture may be viewed as being more than balanced by the fact that the world now is able to feed more people a better diet than ever before. In 1950, the world had 2.5 billion people and some were hungry. Now (in 2005) the world has nearly 6.4 billion people and some (perhaps 800+ million) are regularly hungry. But agriculture now feeds more than 5 billion, a task that most people thought was impossible in 1950. Thus, the balance of pleasure over suffering is significant. What agriculture has achieved must be ranked as among the greatest of scientific achievements. Agriculture in the view of many, presents no special ethical problems (Thompson, 1995, p. 6) because it's albeit real problems pale in comparison to its real achievements.

However, in our world of material abundance for some and hoped for material abundance for millions of others, a dilemma is that to pursue the utilitarian greatest good for the greatest number may lead to destruction of the resource base on which the greatest good is absolutely dependent (Busch et al. 1995,

p. 214). The dilemma is what Durning (1994) calls the conundrum of consumption:

> Limiting the consumer life-style to those who have already attained it is not politically possible, morally defensible, or ecologically sufficient. And extending that life-style to all would simply hasten the ruin of the biosphere. On the other hand, reducing the consumption levels of the consumer society, and tempering material aspiration elsewhere, though morally acceptable, is a quixotic proposal. It bucks the trend of centuries. Yet it may be the only option.

Through what Busch et al. (1995, p. 214—citing Sagoff 1988) call the "stepped-up appropriation and comodification of nature," we may destroy nature and "the very culture that provided us with and fostered the idea that there is a 'greater good' than simple satisfaction of preferences or freedom from material wants." Such goals "presuppose the reality of public or shared values . . . that are discussed and criticized" (Sagoff, 1988, p. 29). These kinds of values should not "be confused with preferences that are appropriately priced in markets" (Sagoff, 1988, p. 29). Thus, agricultural ethical debate is required to aid in decisions when there is tension between the imperative to produce and the values inherent in the need to conserve or protect the resource on which production depends. Such debate will help resolve the conflict between the agrarian philosophy that wants to protect family farms and those who value the economic efficiency of large-scale industrial agriculture to produce cheap, abundant food. An agricultural ethic will help us address the losses of biodiversity from large-scale but highly productive monocultures. The ethic will guide resolution of the tension but not dictate the answer. It is not feasible to transfer the tenets of environmental ethics to agriculture because environmental ethics has consistently given conservation priority over productive use. It is clear that only difficulties would result from attempts to make environmental ethics applicable to agriculture. For example, an ethic for wild areas is not applicable to agricultural areas.[2] Agriculture needs its own environmental ethical foundation to achieve sustainability.

However, one is still left with the questions—what exactly is it that is to be achieved by the quest for sustainability and why should we work to achieve it? What are the characteristics of a sustainable agricultural system? There is, as mentioned at the beginning of this chapter, a disorienting array of interpretations of sustainability.

[2] Some of these thoughts are derived from Boyd, F. 1997. Do we need an environmental ethic for agriculture? Unpublished.

HIGHLIGHT 7.3

The related terms, "sustainable" and "sustainability" are popularly used to describe a wide variety of activities that are generally ecologically laudable but may not be sustainable. Any firm and unambiguous definition of the concept of sustainability must accept that it has to mean—for an unspecified long time. It implies increasing endlessly, which, of course, means that whatever is growing will become infinite in size or scope. If one accepts, as one must, that the earth is finite and its resources and the environment are not infinitely expandable. Then one must accept and understand what Bartlett calls the most fundamental truth of sustainability: when applied to material things the term sustainable growth is an oxymoron. These principles are the foundation of Bartlett's laws of sustainability (Bartlett, 1999).

They lead to the ineluctable conclusion that a sustainable agricultural system is "one that meets the needs of the present without compromising the ability of future generations to meet their own needs." Bartlett concludes with his laws of sustainability, some of which are applicable to agriculture's quest for sustainability.

1. Growth in rates of consumption of resources cannot be sustained.
2. In a society such as the US, as population and consumption of resources grow it becomes increasingly difficult to become sustainable.
3. The size of a population that can be sustained (the carrying capacity) and the average standard of living of the population are inversely related.
4. Sustainability requires that the population's size be less than or equal to the carrying capacity of the ecosystem in which it exists.
5. The benefits of population growth and growth in rates of resource consumption accrue to a few; the costs are borne by all of society.
6. Growth in the rate of consumption of a non-renewable resource (e.g., fossil fuel) cause a dramatic and rapid decrease in the life expectancy of the resource.
7. The benefits of efforts to preserve the environment are easily overwhelmed by added demands placed on the environment by more people who demand more things.
8. Humans will always be dependent on agriculture.

William Jennings Bryan the Democratic candidate for President of the US in 1896 affirmed the essentiality of agriculture, and thus of its sustainability (he did not use the word) in his Cross of Gold speech. He said:

> Burn down your cities and leave our farms, and your cities will spring up again as if by magic; but destroy our farms and the grass will grow in the streets of every city in the country.

WHAT IS SUSTAINABILITY?

The International Alliance for Sustainable Agriculture held a conference in 1990 at the Asilomar conference center in California. The Asilomar declaration[3] for sustainable agriculture was approved by the more than 800 delegates who attended the conference. It begins with the assertion that "the present system of American agriculture cannot long endure." The destructive consequences of regarding agriculture as an industrial-technological process rather than a biological/ecological one (Merrill, 1986) are implicit in the Asilomar Declaration. The challenge is not simply to increase production, in fact, production is not even mentioned as a goal because if sustainability is achieved, production is assured. To sustain is defined in the dictionary sense of—to keep in existence; keep up; maintain or prolong; to keep up without interruption, diminution, or flagging. The challenges of the Asilomar Declaration are:

1. To promote and sustain healthy rural communities.
2. To expand opportunities for new and existing farmers to prosper using sustainable systems.
3. To inspire the public to value safe and healthful food.
4. To foster an ethic of land stewardship and humaneness in the treatment of farm animals.
5. To expand knowledge and access to information about sustainable agriculture.
6. To reform the relationship among government, industry, and agriculture.
7. To redefine the role of U.S. agriculture in the global community.

To this list one could add preservation of nature, which can be achieved by preserving farmland as a buffer between developed urban areas and wild areas (Westra, 1998). In accordance with Westra's (p. 28) sixth, second-order principle, an ethic of integrity requires that humans view all activities as taking place within a buffer zone that shields and protects core, ecologically intact, wild areas. "True buffers entail that most natural ecologically evolutionary processes be present," although such areas may be manipulated for agriculture and forestry. Such manipulation must not impose degradation or disintegrity on the agricultural or care landscape (Westra, p. 138).

These seven things are social, environmental, agronomic, and economic goals. They define agriculture as more than just a productive activity. Sustainable agriculture is to be regarded as the salvation of our souls (Merrill, 1986). "From agriculture we learn that we are not sufficient unto the day—that we do not and can not have all the answers." Our vast agricultural technological efficiency has given rise to a new question that has not been answered. The question posed

[3] The document is available from The Newman Center at the University of Minnesota.

by Pettersson (1992) is relevant, "How successful should we be in controlling and manipulating nature or its ecosystems?"

A simple definition that incorporates sustainability's complexity is that prepared by the U.S. Alliance for Sustainability (2004). It suggests that a sustainable agricultural system must satisfy four criteria. It must be:

Ecologically sound—Able to achieve species diversity and be resource efficient to conserve resources, avoid system toxicity, and decrease input costs.

Economically viable—The system must yield a positive net return when resources expended are compared to those returned. In short, it must be profitable.

HIGHLIGHT 7.4

Wes Jackson earned a B.A. in biology from Kansas Wesleyan, an M.A. in botany from the University of Kansas, and a Ph-D in genetics from North Carolina State University. After obtaining his Ph-D he returned to his alma-mater to teach biology. Subsequently he moved to California State University in Sacramento and established their program in Environmental Studies. After becoming a full Professor at California State University, his career diverged dramatically from most who obtained a doctorate in some field of agriculture and began an academic career. He left academia and founded the Land Institute in Salina, KS.

The Land Institute has studied the problems of agriculture for more than 20 years from a very different perspective than that found in most Land Grant Colleges of Agriculture. Jackson decided that modern chemical, energy, and capital intensive agriculture although highly productive of food and fiber was inevitably unsustainable and doomed to fail. What was needed was a new model for agriculture It was to be a model based on the land ethic of Aldo Leopold[4]:

> A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.

The model Jackson chose to achieve the goal Leopold established was the prairie. Many well-established, respected agricultural people scoffed. The comments were similar to: Prairies don't produce food and fiber, they produce prairies. Prairies might be good for some cattle grazing but not for producing food crops.

[4] Leopold, A. 1966. *A Sand County Almanac—With essays on conservation from Round River.* Ballantine Books, New York, NY. P. 262.

Jackson also claimed his goal was to develop a high-yielding, seed bearing, perennial, polyculture. The response from the traditional agricultural community was the, quite reasonable, botanical claim that perennials put their energy into perennial structures (roots, rhizomes, stolons, tubers) not into seed production. Perennation and high seed yield don't go together. Besides, the doubters said, perennial plants that grow on prairies don't produce seeds that humans will eat. They are not palatable; they taste bad.

Ah, but prairies are highly sustainable. Without human disturbance they have survived and remained productive for centuries. Prairies don't have weed, disease, insect, or fertility problems. And, if they do, they recover on their own. Prairies sponsor their own pest control and fertility and don't need to be irrigated. A prairie does all that a sustainable agricultural system ought to do. They do what modern agricultural systems fail to do. A prairie is place to begin to try to learn what nature has to teach.

The Land Institute does what Land Grant Colleges of Agriculture have not done, or, at least, the efforts of colleges to develop a new model are not readily apparent. The Land Institute consults nature, which is regarded as the source and measure of the membership of humans in the natural world. The Institute is designed to develop an agriculture that preserves rather than destroys soil and assures the life of rural agricultural communities.

Scientists at the Land Institute are now confident that they have demonstrated the scientific feasibility of natural systems agriculture. They anticipate that such systems can and ought to be adopted worldwide. The prairie will obviously not be the proper model for all world agriculture. Models must be found in local ecosystems. Diamond (2005, pp. 280–282) provides a clear example of what can be learned from agricultural systems that have survived for centuries but to the western eye appear primitive. For example New Guineans irrigated sweet potato gardens with vertical ditches that ran down the slope, not across the slopes or along a contour. A European agricultural advisor convinced them to re-orient the ditches with the result that the next heavy rain washed ditches and crop away. These primitive folk had learned, over centuries, what worked. They had a highly sustainable, productive system that fed people, conserved soil, rotated crops, prevented erosion, added organic compost, and combined annual crops and forests. It was not modern, but it was successful and a model from which modern folk could learn.

The principle that one can learn how to practice agriculture by studying and learning from the natural systems and successful farmers that exist in all world areas should be accepted as a place for all engaged in agriculture to begin to work toward agricultural systems that sustain food production and people.

Socially just—Resources and power must be distributed equitably so basic needs of all are met and rights are assured. People must be empowered to control their lives. It is in Sen's (1999) term, development as freedom.

Humane—Good farmers are humane. They are kind, tender, merciful, and sympathetic to all life forms, even though the practice of agriculture changes the environment and affects other creatures. Humans have an interdependent relationship with animals and those who raise animals (e.g., ranchers) know that if they care for their animals, the animals will care for them.

A sustainable agricultural system must be all of these things but one more element must be added—it must be political acceptability. Any system that includes each of the four elements but is not politically acceptable is doomed to fail.

WHY MUST SUSTAINABILITY BE ACHIEVED?

The Asilomar challenges address the questions posed by Kirschenmann http://www.leopold.iastate.edu/fredspeech.html, accessed October 2000). He acknowledges that philosophers have the annoying habit of asking questions "that the prevailing culture doesn't like to ask" or to answer. It is the task of philosophy to ask such questions, even when they disturb the prevailing culture. Societies typically try to ignore such questions and if that doesn't work, some troubling people are killed: Jesus was crucified, Socrates was compelled to drink the hemlock juice (he did, although he could have left town), Mahatma Gandhi, Martin Luther King, and Abraham Lincoln were assassinated.

Agriculture and its practitioners have ignored challenging ethical questions and continuing to ignore them can only worsen and weaken agriculture's position in society and the quest for agricultural sustainability. As mentioned at the beginning of this chapter, all seem to be in favor of sustainability. It is universally regarded as a good thing. But the agricultural community has not provided reasons to sustain anything other than production and profit. Modern capital, chemical, and energy dependent agriculture however, is "neither always full of promise nor profit" (Thomas & Kevan, 1993). For example production expenses increased more than 100% from 1970 to 1986 while net farm income remained nearly stable, one-fourth of all farm loans were non-performing or delinquent, farm debt to asset ratios increased dramatically, and farm machinery sales dropped (Nat. Res. Council, 1989, pp. 90–93). Keeney (2003) claims that the U.S. agricultural policy, established in 1970, that U.S. agriculture should feed the world has failed the world (nearly as many of the world's people are hungry now as were hungry in 1970), the U.S. (many Americans are hungry and half of us are overweight) and agriculture (massive, expensive farm supports have harmed the environment and harmed family farms). The policy was based on economic

rationality and the quest for ever greater profit. It was, in Keeney's view, an agribusiness, not an agricultural vision. It was not and is not sustainable.

Tinkering at the margins won't make modern agriculture sustainable or more profitable. Long-term sustainable agriculture is not and cannot be simply maximizing commodity production per acre (Thomas & Kevan, 1993) and profit. Clearly these are what philosophers call necessary but not sufficient conditions to achieve a sustainable system. They are at best, adequate economic criteria but they lack an ethical foundation.

If production and profit are inadequate criteria of sustainability, one must ask what other conditions must be satisfied? Thomas and Kevan (1993) propose that sustainability must include land practices that "operate at lower levels of purchased inputs" and that overtly embrace agroecology and incorporation of natural processes that allow production to work with rather than against the natural system.

Gale and Cordray (1994) discuss what should be sustained and give nine answers to the question, preceded by four essential questions: What is to be sustained? Why sustain it? How is sustainability measured? What are the politics? Or one might ask, Who benefits and who loses? In Table 7.1, the matrix shows the relationship among the four essential questions and the things one might choose to sustain (Gale & Cordray, 1994).

Most of agriculture's concerns are in the first item (dominant product) in Table 7.1. The emphasis of the agricultural establishment has been on the value of producing an abundance of high-valued crops. The justification has been the economic efficiency of producing large quantities of desired goods and the necessity of maintaining the flow of the specific agricultural resources the market demands. This position does not implicitly neglect agriculture's social dimensions and the human benefits. A good society and improved human health are regarded as the inevitable outcome of sustaining crop and livestock production. Ecosystem integrity and diversity (the third and fourth items in the table) are not undesirable goals within the agricultural community but they rarely, if ever, assume dominance over sustaining production. A major point of Gale and Cordray's (1994) work is that while all agree that sustainability is a good agricultural goal, the debate about what is to be sustained in addition to the yield of high-valued products, has barely begun within the agricultural community.

Those who practice agriculture have reached the ethical plateau where all humans are to be treated equally and animals are, at best, to be treated without cruelty. Where animals and other creatures fit in an ethical progression accepted by most people is shown in Table 7.2.

People in the agricultural community are always challenged by discussions of non-human animal rights and the ethical treatment of non-human animals. If the rights of animals are dismissed as just another useless academic debate before debate has begun, little good can follow. Few in the agricultural community are willing to give non-human animals the rights they routinely and without

TABLE 7.1 Sustainability types and four defining questions (Gale & Cordray, 1994)

	Four defining questions			
Sustainability type	What is sustained?	Why sustain it?	How is sustainability measured?	What are the politics?
Dominant product	Yield of high-valued products	Economic efficiency	Quantity produced	Maintain flow of narrow resource-specific resources versus broad, diverse resource production
Dependent social systems	Social systems communities, families	Life style values	Social system persistence	Local, targeted resource-dependent social systems versus broadly distributed use or preservation
Human benefit	Diverse human benefits	Human rights to resource abundance	Range of ecosystem products and uses	Broadly distributed multiple uses versus ecocentrism or resource specialization
Global niche preservation	Globally unique ecology	Global human-ecosystem	Ecosystem health	"Spaceship earth" versus which niches to maintain
Global product	Globally important high-value products	Human need for products even if few areas produce them	Price and supply fit of local products into int. market	International comparative advantage versus global exploitation and resource nationalism
Ecosystem identity	General types of ecosystems or resources uses	Commitment to general ecosystem diversity	Persistence of global ecosystem diversity	Worth of general ecological characteristics versus market-driven ecosystem conversion
Self-sufficiency	Ecosystem integrity	Commitment to ecosystem autonomy and naturalness	Ecosystem integrity without external input	Ecosystem rights and values versus human values and needs
Ecosystem insurance	Ecosystem diversity	Insure against ecological disaster and diversity loss	Vitality and amount of insured resources, resistance to ecological crises	General need for reserved areas versus questions of future need and technological optimism
Ecosystem benefits	Undisturbed ecosystems	Respect rights inherent in natural ecosystems	Ecosystem continuity natural evolution	Restorative intervention or ecocentric autonomy versus human dominance and use

TABLE 7.2 An ethical progression (Nash, 1977)

The intrinsic value of the environment	
Future	Life in general
	Plants
	Non-human animals
	Non-human mammals
Present	Humans
	One's Race
	One's Nation
	One's Tribe
The ethical past	Family
	Self

question give to human animals: the right to a full life, freedom from suffering, the right to raise descendants, freedom from torture. Students struggle with the challenges offered by Singer (1975) who claimed as Bentham did, that all sentient beings should have equal consideration (not including the right to vote or own a bicycle) because all can suffer. The capacity for suffering and enjoyment are necessary and sufficient conditions to say that, without question, non-human animals deserve equal consideration. Unnecessary suffering should be stopped.

Those who practice plant or animal agriculture have not progressed to the level of ethical concern prescribed in the famous statement and environmental challenge from Leopold (1947, p. 262).

> A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise.

The endless, and not undesirable, quest for production in agriculture is obviously not concerned with the integrity, stability, or beauty of the biotic community. Agricultural practice does not inevitably produce ugliness or lead to instability, although it does destroy stability, especially when it is based on uniform (over large areas) monocultural crop production. In fact cropped fields can be quite beautiful (amber waves of grain). But the beauty is temporary, created only to be destroyed and, one hopes, created again next year. It is not the beauty of permanence, of a stable biological community. It is not a beauty or stability that is created because of an ethical stance similar to the physicians ethical code: *Primum non nocere*—Above all do no harm.

The practice of agriculture has changed from something that many people did, often because they had to in order to survive, to something that few people do. Somewhere along the way it also changed from one that worked with nature, because those who farmed were subject to the vagaries of climate and weather.

They had no choice, and although agricultural practice is still subject to the weather (hail, drought, and severe storms ruin crops), humans have much greater control than was possible 50 years ago. Development of improved ability to control nature occurred with the perception that humans had the right (indeed the obligation) to control nature. Agricultural scientists were able to ignore the ecological basis of agricultural practice and, in turn, ecologists ignored agriculture because it was not part of natural processes. Agriculturists knew they were building a sustainable production system and ecologists knew that was not true, but they did not often speak to each other. As technological solutions to agricultural production problems began to fail (pest resistance appeared, groundwater receded, soil erosion continued, fertilizers and pesticides polluted water, petroleum energy became more expensive, and pesticides harmed humans and non-target species) production became more complicated and less profitable. Sustainability became a highly desired goal but neither the question of what to sustain nor the question of why achieving it was necessary, had been answered.

Sustainability is about the future. We cannot sustain the past and today is fleeing as we live it. It seems clear that we want to preserve something for tomorrow. What is not clear is what our obligation to the future may be, if we have one at all. It is a common philosophical position that we have no obligation to future generations because it is hard to prove that non-existent future generations have rights. The argument is that to have a right is to be a present bearer of the right. Because future generations do not exist they cannot bear rights or claims against present people. However, Burkhardt (1989) argues that we can decide that future generations have rights or that we ought to think they do. Those who have them care deeply about their children and grandchildren and may choose to extend their care to generations yet unborn. What we do now in agriculture may affect future generations. We inherited a world that supports us and we can choose to assume the obligation to treat the world in such a way that we pass it to those who follow in as good or better condition than it was in when we received it. We have or we can assume an obligation to sustain and improve the world. At the very least, we can posit that future generations have a right not to be harmed and the right to be helped, which may be equivalent to a right not to be harmed. Therefore, Burkhardt (1989) suggests that future people ought to have rights which present people have a duty to assure. These rights include:

- The capability of the earth to provide sufficient food for however many people they democratically decide it is in their interest to support.
- Scientific knowledge and technologies that can assist them in the provision of sufficient supplies of food, clothing, and shelter, subject to their own environmental and cultural values.
- Democratic institutions that promote the active participation of all people in addressing whatever problems they might encounter or set themselves.

- A tradition of moral trust and respect such that values of community and the excellence of human life can be live and promoted.

As Burkhardt (1989) says, "it seems clear the earth should not be dead when future generations arrive." That means its productive capacity and the institutions that enable that capacity must be sustained by those who precede them. Agriculture has therefore, an obligation to feed present people and maintain its productive resource base. It also has an obligation to contribute to democratic institutions and caring communities. Burkhardt (1989) argues that "any set of practices, policies and institutions that respects the environment, including non-human animals, can be morally adequate. Any farming system that feeds people enough high-quality food is adequate to achieve sustainability. It is not the system or its components that are critical, it is its achievements that will lead to sustainability that are in the interests of all present and future generations and are the obligation of all. Because it is a shared obligation, it is essential that societies collectively define and work to create the kinds of economic, educational and political institutions so that all, including those directly engaged in agriculture can act on the obligation to achieve sustainability.

A CONCLUDING COMMENT ON SUSTAINABLE WEED SCIENCE

During my academic career I have met many people who, on learning that I was a professor, would often ask, "What do you teach?" Now, it is the right question and I am eager to answer. Early in my academic career, I thought it was the wrong question, because I wanted to talk about my research and the importance of weed control. What I wanted to tell people was not what they were asking. I began to wonder if I had the right stuff. Wolfe (1979) writing about the Apollo astronauts let me know I did not and told me that some did. "The world was divided into those who had *it* and those who did not. This quality, this *it*, was never named, however, nor was it talked about in any way." Some had *it*, the right stuff, most did not.

I knew some of my weed science colleagues had the right stuff. They, in Wolfe's words had "the moxie, the reflexes, the experience, the coolness" to think of and answer questions about weed control that most weed scientists thought were the right questions. For me, they were the elite, those who had the right stuff to acquire resources and organize people to ask and answer the right question. Now in the twilight of my professional life, I still believe some of those superb colleagues had the right stuff, but I am no longer sure they had the right questions.

The most important question of my early years in weed science was, What is the identity of the problem weed? The second question was, How can it be

controlled, which included asking, What herbicide will be most effective for controlling the weed, selectively? These are good questions and they are still asked frequently. They are not the most important questions. It is my view that their persistence has, at once, enabled weed science to make important contributions to agricultural productivity while obscuring the right questions. The questions we have been asking have been consistent with the dominant production paradigm of modern agriculture. Acceptance of this paradigm has placed increasing production as a high, if not the highest, value and most weed scientists regard employment of all appropriate modern technology to achieve and maintain profitable production as prudent and correct. The conviction is that the highest level of production or weed control that can be achieved profitably is the best level. The paradigm includes an unexpressed, fundamental assumption of the unqualified right of humans to transform, control, and dominate nature to achieve production of food, which is essential for life. Giampietro (2004, Preface and Introduction), from a quite different perspective, also suggests agricultural science has failed to alter its operative paradigm to properly address issues of agricultural sustainability.

We manipulate the natural world to produce food, and weeds are an inevitable part of food production but the emphasis on control has obscured the right question, which is: Why is the weed where it is? That is to say, what is it about the production system or the way we practice agriculture that allows a specific weed or weed population to be so successful? The right question is a systemic, holistic one that accepts transformation of nature as a necessary prerequisite to food production but rejects domination of nature. Transformation of nature may yield weeds; an undesired result. Weed control is not bad or forbidden when the right question is asked. But control is subsumed under vegetation management. The right question, a question of applied ecology, is compatible with the quest for sustainable agriculture and holistic understanding, because it is derived from ecology, a discipline that studies the principles that regulate distribution and abundance of species in communities. Weed scientists, myself included (Zimdahl, 2004), have asked how a certain density and duration of weeds affects crop yield. We have asked these questions to gain an economic answer to a production question. How many weeds are required to reduce crop yield more than the cost of weed control? When we know that answer, we ask how to control the weeds selectively and profitably. The right question will not forbid asking what to do but it demands that research begin with a *why* question rather than a *what* question. A *why* question leads toward development of a foundational theory to guide weed science. *Why* does something happen? *What* questions are fundamentally empirical and their answers reveal what to do, but not necessarily why a particular course of action is best or why it should be taken. Control questions, those that ask what to do, frequently yield short-term solutions and do not lead to what Berry (1981) calls "a ramifying series of solutions," which are in harmony with the larger patterns in which they are contained. Until the right questions

are asked and the characteristics of a production system (the larger pattern) that create opportunities for weeds to succeed are understood, we will continue to develop and recommend employment of short-term solutions to weed problems. Weed science and successful, sustainable agriculture systems are, or should be, derived from studies in applied ecology. Experiments designed to ask why questions based on the ecological principles that regulate the abundance and distribution of weedy species in disturbed, cropped environments will be asking the right questions to achieve a sustainable agriculture.

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Biotechnology

> *"I am thy creature, and I will be even mild and docile to my natural lord and king if thou wilt also perform thy part, that which thou owest me. Oh, Frankenstein, be not equitable to every other and trample on me alone, to whom thy justice, and even thy clemency and affection, is most due. Remember that I am thy creature; and I ought to be thy Adam, but I am rather the fallen angel, whom thy drivest from joy for not misdeed. Everywhere I see bliss, from which I alone am irrevocably excluded. I was benevolent and good; misery made me a fiend. Make me happy and I shall again be virtuous."*
>
> *"Begone! I will not hear you. There can be no community between you and me; we are enemies. Begone, or let us try our strength in a fight, in which one must fall."*

Chapter 3 suggests that biotechnology has changed the debate about the criteria used to determine the acceptability of any agricultural technology by introducing a new question—Do we need it? The question could also be moral rather than just scientific or economic, by asking—Ought we to do it? In the above quote from Mary Shelley's *Frankenstein* published in 1818, all will recognize the monster Dr. Frankenstein created as the parable of perverted science, of science gone bad (Warner, 1994, pp. 29–30). What we may fail to see is Shelley's more important message in Dr. Frankenstein's response (the last three lines above) to his monster's plea. Scientists might make a monster in their own image but then be incapable or unwilling to take responsibility for what they have created. Shelley recasts the monster in the image of Dr. Frankenstein, its creator. The monster is Frankenstein's brainchild; his double and serves to define his creator (Warner, 1994, p. 30).

The dilemma is one that plagues biotechnology. Will biotechnology create another monster and will its creators then be unable to accept responsibility for the bad behavior of their creation or is biotechnology the next great scientific step that will benefit all? Surely the new technology shows vast promise of crops that are more pest-resistant and nutritious. As mentioned in Chapter 5, Kirschenmann and Youngberg (1997) suggest that in spite of the presently heated

controversy, biotechnology will be the primary force that shapes tomorrow's agriculture. The world's farmers (primarily in Argentina, Brazil, Canada, China, South Africa, and the U.S.) planted 68 million hectares of GM crops in 2003 (CropBiotech Net, 2004) and the area planted continues to increase.

THE DEBATE

The debate about biotechnology is similar to others that have occurred about agricultural technologies (e.g., pesticides). DeGregori (2001, p. 125) states the scientific perception of the problem when he says, "public discourse is being driven by emotional language." Borlaug (2001) argues that scientific progress "must not be hobbled by excessively restrictive regulations." If we are to meet the needs of the 8.3 billion people that may be on our planet by 2025, Borlaug claims that conventional technology and biotechnology will be not just needed, but essential. He also claims that "extremists in the environmental movement, largely from the rich nations or the privileged strata of society in poor nations, seem to be doing everything they can to stop scientific progress in its tracks." The Economist magazine (2004a) opines that "scaremongering by western green activists has discouraged investment in such valuable research." Borlaug acknowledges agriculture's debt to the environmental movement because their efforts have led to "legislation to improve air and water quality, protect wildlife, control the disposal of toxic wastes, protect soil, and reduce loss of biodiversity." However, now the anti-biotechnology extremists have gone too far and their policies will have "grievous consequences for the environment and humanity." It is mildly ironic that Borlaug claims this in spite of the fact that those in the environmental movement are continuing to pursue improvement of the same things for which he thanks them.

The scientific view is "science can determine a fact, that these facts represent objective reality, and that values or beliefs play no role in determination of facts" (Barker & Peters, 1993, p. 5). Science is objective and value-free, as it should be. It is not the scientist's task to create or change social, economic, or political policy according to Barker and Peters (1993). Objective science is driven by curiosity about the natural world, the mission of the employing institution, and the demands of the funding that enable the research. Scientists attempt to understand and explain the natural world and technology applies scientific findings to the world. In general, science has been regarded by the public as good and technology was judged to be good or bad depending on how it was used (Boulter, 1997). However, science, in general, has moved from being viewed as an unalloyed public benefit (e.g., better living through chemistry) to being regarded with suspicion, if not outright distrust. Scientists used to be seen as being guided by a wholesome curiosity and a search for the elusive truth. Now the public is wary. It is well known that science, similar to many other human activities, is strongly

influenced by social, economic, and political pressures (Boulter, 1997). It is equally well known that some bad consequences, scientists said were unlikely, have happened. For example, there are pesticides in some drinking water supplies and food, nitrates pollute water, space shuttles fail, airplanes fall from the sky.

HIGHLIGHT 8.1

The Anheuser-Busch company announced recently that it will not buy rice grown in Missouri if genetically modified drug-containing crops (crops modified to produce a pharmaceutical product) are allowed to be grown in the state. Anheuser-Busch, headquartered in St. Louis, is the largest buyer of rice in the U.S. Ventria Biosciences has requested permission from the state of Missouri to grow 200 acres of rice that has been genetically modified to produce human proteins from which drugs could be made. This biopharming project is designed to lower the costs of drug manufacture by using plants to produce a drug. The most common fear is cross contamination of non-genetically modified crops, grown nearby. Biopharming projects have been growing for nearly a decade although many are concerned that there has not been sufficient scientific study to assure the safety of such crops (Hahanel, 2005).

Public and scientific debates about biotechnology often appear to be dominated by polar opposite views. The debaters don't really speak to each other. The disputes are frequently based on scientific facts—often selected facts—but the disputants nearly always disagree over the story (Charles, 2001). All of the stories are, in some sense, true, especially when one knows the preconceptions of the storyteller. The dispute is over the goodness of the characters (their virtue or lack thereof), the plot (why is this happening?), the editing (what facts count?), and how it will all end (Charles, 2001). Charles provides examples of the relevance of the story (myth) metaphor by contrasting deeply embedded stories that affirm the possibility of progress, discovery and creativity, problem solving, and expanding the boundaries of human possibility with other stories ("the countervailing myths"), which affirm that technology is unpredictable, threatening, and a product of human folly that believes it can (and should) control the world.

What one hears or reads in these conflicting stories is often not a reasoned debate of the issues. It is a presentation and defense of one of the polar views: biotechnology is good and required to feed the expanding human population vs. biotechnology is bad (for a variety of reasons, especially the unpredictability of future effects) and will not help feed people. There are notable exceptions. It is the purpose of this chapter to present and explore the debate (some of the stories) about biotechnology.

TECHNOLOGICAL PROBLEMS

Giampietro (1994) notes that it "is dangerous to convey to the general public the idea that problems faced today by humankind can be fixed without changing cultural and political paradigms, remaining in the business-as-usual mode, just by working out a better technology." Genetic engineering, he acknowledges is like other technologies, in that its useful or harmful effects will be determined by how it is used. We humans tend to analyze and address the problems that bother us now, fix those problems when possible, and ignore long-range problems because, well, they are long range and there are so many other problems demanding immediate attention. Ecological problems are frequently long-range in the sense that they don't appear quickly, cannot usually be addressed by quick, short-term solutions, and the best solutions require a long-range, historical/ecological perspective. Biotechnology is regarded by many critics as one of the quick fixes that ignore long-range potential problems while focusing on short-term benefits. Without a long-range perspective many solutions create a new set of problems that require more quick fixes but do not yield true solutions (Giampietro, 1994). The solutions that proponents of biotechnology suggest seem to be the kind that Berry (1981) deplored because so many made the problem worse. Berry (1981) advocated solving for pattern and identified three kinds of solutions to any problem. The first solution (that he deplored) causes a ramifying series of new problems, the second immediately worsens the problem, and the third, and most desirable solution, creates a ramifying series of solutions. The dependence of modern agriculture on technical solutions that depend on declining supplies of petroleum energy to increase food production is not in the latter category. In economic terms such dependence may be right but it may not be sustainable ecologically (Giampietro, 1994) or defendable morally.

Thompson (1987) frames the problem well by suggesting that facts and values about biotechnology are neither "readily separable in the regulatory tangle" or in the public mind. Citizens are aware of some of the issues but scientists do not speak to the public in language that is readily understandable and the media often seems to exacerbate prevailing polar views of what the story is about. Thompson (1987) suggests that the casual reader of available news can easily draw the conclusion that the scientist's story of agricultural biotechnology may be just as likely to defend personal interests as it is to present unbiased judgments. Thus, concerned citizens may shift their focus from the scientific issue to the values of the scientist or the scientific community, which is difficult because these values are rarely explicit. Therefore, the citizen tends to focus on the characteristics and presumed values of the scientist, what Charles (2001) called the goodness of the characters, and the values of the scientific community, which also are rarely explicit.

Lovins and Lovins (2000) point out that with the good goal of feeding the growing human population, agricultural biotechnology is replacing nature's

wisdom with human cleverness. Nature and natural systems are not guides but obstacles. Nature is to be restructured to meet what all agree is a good goal—feeding people. Lovins and Lovins (2000) article is in the center of a longer article by Joy (2000), who no one should identify as an opponent of new technology. Joy argues that "new technologies like genetic engineering . . . are giving us the power to remake the world" and we risk "failing to understand the consequences of our inventions while we are in the rapture of discovery and innovation." He identifies this as a common fault among scientists and technologists.

REGULATION

Andrews (2002) and Lovins and Lovins (2000) identify a critical commonality among the products of agricultural biotechnology: "they are different enough to patent but similar enough to make identical food." The accepted definition of a transgenic organism (a more precise term) is that it is one that contains an inserted gene sequence that could not have been acquired by natural or artificial (i.e., human facilitated) hybridization. Those who create and sell transgenic (i.e., genetically modified) crops have convinced the U.S. Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA) that the inserted genes are products of nature (they are naturally created) and therefore no different from their non-engineered cousins. However, at the same time, they have persuaded the U.S. Patent Office that the genetically engineered crops are not products of nature (the characteristics could not have been acquired naturally) and are different enough to be patented (Andrews, 2002). Thus, we find the European Union's insistence on labeling so people have the freedom to choose what they want to eat or not eat, is what Borlaug (2001) would call environmental extremism and what many scientists call an emotional response without any scientific foundation. Others call the EU position an irrational (i.e., non-scientific) barrier to free trade.

Food from biotech crops is similar enough to non-biotech crops to eat, because the U.S. regulatory community has accepted the concept of substantial equivalence to assess the risk of genetically modified (GM) food. Substantial equivalence involves quantitative, chemical analytical methods of evaluation to determine if key nutrients or anti-nutrients in plants to be used for food or feed have been changed by genetic modification (Anonymous, 2004b). The analysis considers essential vitamins, minerals, fatty acids, carbohydrates, amino acids, naturally occurring toxicants such as erucic acid and glucosinolates in canola or solanine in potato. Analyses may also consider allergenic proteins in common foods such as soybean and wheat (Anonymous, 2004b). To determine substantial equivalence, health and regulatory officials consider natural variation, the changes that may be introduced by processing, and the food's intended use by the general population. The tests are what Pouteau (2000) calls a reducing concept because

they ignore the effects of much of the production and processing of food that occurs between harvest, the store, and the table.

The concept of substantial equivalence was first described in 1993 and implemented in 1998 by the OECD (Organization for Economic Cooperation and Development) (OECD, 1993; Pouteau, 2000). The concept has been accepted for regulation of GM foods by the United Nations Food and Agriculture Organization (UN/FAO), the World Health Organization (WHO), and by the U.S. government. According to Pouteau (2000), the process used to determine substantial equivalence was never intended to be a substitute for true safety evaluation. It is a chemical analytical process that compares the composition of a GM food or feed with a non-GM food or feed that humans or animals already consume with no evidence of harm. It has been used widely for decision making about the safety of GM foods. Clark and Lehman (2001) provide citations in support of and in opposition to GM crops and then cite Domingo (2000) to show that widespread use of GM crops has not been preceded by "rigorous, scientifically defensible analysis of benefits and harms." The quantitative, chemically supported concept of substantial equivalence has been used to determine safety for users and the environment. Clark and Lehman (2001) produced Table 8.1 from Domingo's (2000) data that he obtained from the Medline database (http://www.ncbi.nlm.nih.gov/pubmed/) to illustrate that opinion rather than scientific evidence has dominated safety determination. Thus, according to the work cited by Clark and Lehman (2001), eight, mostly rodent-based studies were (in 2001) all the peer-reviewed data available on the safety of GM food. They conclude that widespread commercial adoption of GM technology has not been preceded by a "rigorous and scientifically defensible assessment of benefits or harms for consumers or primary producers, for the Third World, for biodiversity, or for the environment." They call substantial equivalence "argument by analogy." If crop X is chemically similar to crop Y and X has not caused any obvious harm to humans or animals that consume it, then Y must also be safe. There is no

TABLE 8.1 Opinions vs. experimentation in the refereed literature on GM food safety (adapted from Domingo, 2000 by Clark & Lehman, 2001).

		Number of citations specifically related to the question	
Base phrase for Medline database search	Total number of identified citations	Citations reporting experimentation	Citation of opinion without experimentation
Toxicity of transgenic foods	44	1	7
Adverse effects of transgenic foods	67	2	16
Genetically modified foods	101	6	37

independent, peer-reviewed, scientific evidence of safety to anything. The use of substantial equivalence as the primary determinant of acceptability and presumed safety is a commercially approved, political/regulatory decision that is not based on any requirement for scientific evidence of safety. It is not far off the mark when Lovins and Lovins (2000) note that our "technical ability has evolved faster than social institutions; skill has out run wisdom."

The system has contributed to, if not created, the polar views mentioned above. Advocates point to achieved and proposed benefits and downplay assumed risks. They argue that substantial equivalence is accepted by regulators charged with assuring safety and that there is no scientific evidence of harm to anyone (Clark & Lehman, 2001; Degregori, 2001). Those who object, take the view that absence of evidence is not evidence of absence because possible effects may take years to appear and the right studies are not being done or even planned. The claims sound very similar to those made about organo-chlorine insecticides and pesticides in general in the 1960s and '70s and similar to the defensive claims made by manufacturers of cigarettes and polychlorinated biphenyls (PCBs) (Clark & Lehman, 2001). Caution is appropriate given the example of chlorinated fluorocarbons (CFCs) and their well-documented effects on atmospheric ozone. They were used widely because the best scientific evidence showed they were simple, inert chemical compounds that could not cause any environmental harm.

Pouteau (2000) recommends inclusion of substantial equivalence as the first level of evaluation. It would be succeeded by her concept of qualitative or non-substantial equivalence. The concept includes country of origin, methods of production, mode of harvest, methods of conservation, and methods of processing. Some of these can be analytical but most, in her opinion, would escape detection by the substantial equivalence screen. Pouteau (2000) then advocates that products be evaluated for their ethical equivalence. This equivalence includes ethical criteria for environmental sustainability, socio-economic acceptance (i.e., sustaining human resources), effects on wealth allocation, and socio-cultural effects (i.e., effects on freedom, respect for individual identity, respect for religious and philosophical beliefs). These, as is often true of many ethical criteria, are demanding, non-quantitative, vague standards that the scientific community and general society may resist accepting.

One must note that Pouteau is French and perhaps inevitably, reflects the view of many in the EU that there should be a public forum for evaluation of the social consequences of any technology that has the potential to affect a lot of people (Williams, 1998). Although it seems simplistic, biotechnology applied to food can affect all of us because we all must eat. Short of the U.S. Congress, there is no forum for evaluating the social consequences of any technology in the U.S. (Thompson, 2000b). In Europe this is not true. There the social consequences of technological innovations are debated and the debate can affect a technology's fate (Thompson, 2000b). In Europe, the public accepts that technological choices are simultaneously political choices and therefore they play a

major role in determining the kind of society that results (Middendorf et al. 1998). It seems that in Europe, talk is not cheap. It can make a difference because debate about social consequences means something (Thompson, 2000b). In the U.S., it may be just talk, albeit in good academic journals, newspapers, and magazines, but nevertheless, it is often just talk without social consequences.

ARGUMENTS IN FAVOR OF AGRICULTURAL BIOTECHNOLOGY

Proponents of biotechnology and genetic engineering of crop plants or animals see the techniques as a continuation of rather than a radical departure from what scientists have been doing for decades—manipulating the genome of plants and animals by selective breeding. Humans have been selecting plants for higher yield, greater height, drought tolerance, ease of harvest, and other desirable characteristics for a long time. Similarly we have chosen particular animals for breeding because they gave more milk, produced more beef, were more docile, etc., for a long time. Now, proponents of biotechnology say they are just continuing to do the same things with techniques that allow changes to be achieved faster and more efficiently with better, more predictable results.

HIGHLIGHT 8.2

The fourth in a series of farm-scale trials of genetically modified food crops (oilseed rape, sugar beet, and maize), conducted over 4 years, showed, once again, the GM crops may be harmful to wildlife, e.g., birds, insects, and wild flowers. The problem was not specifically with the crop or its genetic modification. The problems were caused by the herbicides used to control weeds in the crop. Commercial firms (e.g., BASF and Monsanto) have withdrawn and cited the lengthy, continuing, never-ending, and unfriendly regulatory struggle as the reason. Killing common broad leaved weeds, which is exactly what the herbicides were designed to do, was cited as a major concern by environmental groups.

Elsewhere the news is quite different. Seven provinces in China now grow genetically modified poplar trees. The trees have been modified by incorporation of genes from the common bacterium *Bacillus thuringiensis* (Bt) and thus sponsor their own insect control without spraying other insecticides. Chinese scientists are also working to modify larch and walnut trees (see the *Christian Science Monitor*, March 10, 2005, pp. 14, 15). This is the first large-scale growth of genetically modified tress in the world and may herald China's competitive entry into the lumber and paper industries. Perhaps because of inevitable

environmental criticism and government required regulatory approval, both of which are not as critical in China, no other country has planted GM trees on this scale.

One view is that faster growing tress that don't require extensive insect control with insecticides, will produce more biomass for fuel, capture more carbon, release more oxygen, and be environmentally favorable. The Chinese are ready to capture these advantages. They are not as concerned, and perhaps not concerned at all, about pollen drift, genetic drift, or the possibility of the modified trees becoming weedy, invasive species. A value judgment has been made that the advantages outweigh the potential disadvantages and it is full speed ahead.

Chinese scientists have also shown that when two strains of genetically modified rice are grown together in the field on small farms, they produce higher yield (approx. 9%), use less pesticide, and are better for the health of the farmers (who do not use as much pesticide) when compared to farmers who grow non-GM strains of rice. One GM rice strain contains genes from *Bacillus thuringiensis* that encodes a protein that paralyzes the digestive system of insects. The same gene is widely used in cotton and maize. The second rice strain uses a gene from the cowpea (*Vigna unguiculata*) that produces a protein that inhibits the activity of trypsin, a major digestive enzyme, but it acts only in insects. Full government approval has not been given, but the benefits seem to outweigh potential disadvantages.

Scientists have simply switched tools to accomplish the same results achieved by traditional breeding techniques. What is happening is similar to what happened in agriculture when hybrid corn seed, the tractor, synthetic fertilizers, and synthetic organic chemical pesticides were developed and introduced (Bailey, 2002b). As time passed and no major disasters occurred, the public attitude (assuming the public even noticed developments in agriculture) toward these changes shifted toward acceptance. Similar changes are likely to occur with the public's attitude toward genetic engineering. One can be sure that the technology is here to stay. Few will argue that modern agricultural techniques have resulted in no harm but those who favor agricultural biotechnology argue strongly that the benefits have been greater. We now have plants that contain their own insecticide and eliminate the need to apply insecticides in the environment. Other plants are resistant to an herbicide and make weed management simpler and more complete. Pigs and potatoes can be used to produce human proteins for medical use (none have been approved). A vaccine for foot and mouth disease of cattle may come from alfalfa. Oji paper of Japan, a paper manufacturer, has transferred a carrot gene into eucalyptus trees so they will grow well in acidic soil (Economist, 2004a). Cows given supplements of the natural

hormone, bovine somatotrophin (BST), give more milk. It may not be too long until plants that can be grown easily in the U.S. will be engineered to produce vanilla, palm oil, coconut oil, or one of many other plant products that are now produced in the tropics and must be imported. Such developments will be good for U.S. agriculture but will likely be bad for farmers and the economies of developing countries that are dependent on export of tropical plant products.

Chapter 3 claimed that many of the past charges about the evils of agricultural technology have been wrong. Evidence has frequently been exaggerated to support a false claim of danger to humans or the environment. The case that modern agricultural technology has harmed humans because they must eat is much less easy to support than the claim that modern technology has harmed the environment on which agriculture depends. The environmental harm caused by modern agriculture is real and must be diminished. Regardless of whether one thinks modern agriculture is an unsustainable disaster or a system that just needs smoothing of its rough edges, Wildavsky's (1997) evidence should give us pause as we examine the claims for and against agricultural biotechnology. It is indisputable that since the early 1950s, the earth's human population has more than doubled. It is also true that there are too many people (800+ million) in the world who are hungry each day and probably most of the time. To permit this to continue, if it can be prevented, is wrong. However, it is also true that the world's agricultural systems now feed more people a better diet than ever before. The world's farmers feed twice as many people as were alive in the early 1950s. That outstanding achievement is due, in large measure, to the technology used in modern farming. Farming methods and associated technologies, so often maligned by critics, have saved millions from starvation. Technological achievements in agricultural and public health ought to be applauded because without them, many people would not be alive and more of the 5+ billion who are now fed, would be constantly at the edge of starvation.

It may also be true, as many believe, that the world has already passed what can be considered a population sustainable at a western middle-class standard of living. That claim is beyond the scope of this book and will not be debated here. The agricultural community clearly thinks there is a moral responsibility to feed those who are here and those who will be here in the decades ahead. The foundational moral stance is that all humans have a right to eat just because they are human and here. Because humans have a right to food, the agricultural community has assumed the duty to provide that food and regards biotechnology as one way to meet the obligation to produce the required food.

A major advantage of agricultural biotechnology is that by any definition it is what one calls "cutting edge science." It is new, fascinating, rapidly advancing science. Because it is so new, one cannot know what may be discovered or what applications may appear. It is a certainty that the general strategies, the scientific methods, for genetic manipulation that are developed will be applied to several different crops and animals (Herrera-Estrella, 2000). Genetically engineered virus,

insect, or disease resistance or delayed ripening techniques could benefit several crops (Herrera-Estrella, 2000) regardless of the region of the world where they are cultivated. Herrera-Estrella (2000) also points out an infrequently mentioned advantage of biotech crops—in theory, adopting such a crop does not require a farmer to change the farming system. Changes in the farming system may be desired but they are hard to achieve and if yield increases or other desired advances can be achieved without major system changes, adoption will be rapid, as past adoption has been (Kalaitzandonakes, 1999).

This new way of doing what has been done for years—manipulate the genome of crop plants and farm animals—will help, and may be essential, if we are to be able to feed the world's growing population (Borlaug, 2001). Other claims include reductions in pesticide use from incorporation of genes for *Bacillus thuringiensis* (Bt) into several crops to control insect pests and incorporation of resistance to some herbicides into several crops to reduce the need for other, less environmentally favorable, herbicides. For example, trials of modified Bt maize in China have reported yield increases of up to 23% (Anonymous, 2003) and reduced insecticide use significantly. China's efforts have focused primarily on development of insect and disease resistance in crops to reduce the need for pesticides and thereby increase farm income (Pearce, 2002).

Human need has driven the development of some advances in agricultural biotechnology. A good example is incorporation of genes for β carotene production into the rice genome to make Golden Rice (Potrykus, 1999). β carotene is a precursor for the production of Vitamin A, which is essential to prevent blindness. Nash (2000) reported that 3 billion of the world's people depend on rice for a major portion of their daily food supply. TIME's July 31, 2000 cover claimed that "This rice could save a million kids a year." Nash (2000) said that as many as 10% of the world's people are afflicted with some form of Vitamin A deficiency that can lead to blindness. There may be as many as 1 million children who die annually from Vitamin A deficiency and up to 350,000 become permanently blind. Golden Rice was created to address this world humanitarian catastrophe. As many as 30% of the world's people may suffer from iron deficiency (McGloughlin, 1999) and scientists have also worked to increase the iron content of rice cultivars (Goto et al. 1999; Potrykus, 1999).

The promises of genetic modification are, if anything, even more spectacular. We may soon see cereal and other crop cultivars that are tolerant of drought or extremes of heat or cold. Soon, we are told, there will be crop cultivars that are tolerant of (able to grow in) soils high in aluminum, alkalinity, and other previously toxic conditions. Crops might grow well in soils and under conditions where they previously could not grow or not grow with assurance of a good yield. Borlaug (2001) suggests we will see crop plants with improved fertilizer use efficiency, disease control or resistance, and nutritional quality. These things will benefit not only crops and farmers in the developed world but also those in developing countries as illustrated by the work of Wambugu (2000) in Kenya,

who developed, by genetic modification, sweet potatoes resistant to feathery mottle virus, which can reduce yields 20 to 80% (Wambugu, 1999). Sweet potato is an important crop on small farms and a staple of the Kenyan diet. Wambugu (1999) and Sahai (1997) argue that one must balance the possible risks of agricultural biotechnology against the risk of doing nothing to improve food production capability in the world's developing countries. In their view, the risk of doing nothing is a much less defendable moral stance.

Incorporation of genes in plants that will immunize those who consume the plant product against cholera, a common disease, or diarrhea in the world's developing countries (Arakawa et al. 1998; Tacket et al. 1998) is well under way but not yet commercialized. McGloughlin (1999) claims that development of edible vaccines delivered in locally grown crops that are dietary staples, could "do more to eliminate disease than the Red Cross, missionaries, and United Nations (UN) task forces combined, at a fraction of the cost." If she is correct, that claim alone is a clear moral argument to pursue biotechnology.

There is no clear scientific evidence that consuming crop products derived from genetically engineered plants has caused detrimental effects to humans or animals (e.g., 75% of all cheeses contain chymosin, which is, and has been for some time, produced with genetically engineered bacteria). It is claimed that genetic modification introduces new proteins never before encountered by the mammalian digestive system. That may be true, but there is no evidence to support the fear such a claim creates. The mammalian digestive system is quite versatile and all the proteins that have been introduced have been non-toxic and sensitive to heat, acidic and enzymatic digestion (Thompson, 2000b).

Proponents also argue that genetic engineering will reduce costs to farmers, be benign or better for the environment as opposed to modern chemical and energy intensive agricultural technology, and because of extensive testing will not be a threat to the health of humans or other species. A major development has been the spectacular rate of adoption of herbicide resistant crops, especially in the U.S. These crops offer several advantages. The process of weed control is less complicated because one or two applications of a single herbicide will, in many cases, achieve nearly complete control of a broad spectrum of weeds without or with minimal crop injury (Gianessi & Carpenter, 2000). Multiple, expensive applications of combinations of herbicides are no longer required. Soybean growers saved more than $200 million in herbicide costs in 1998 (Gianessi & Carpenter, 2000) by using fewer, less toxic, or less persistent herbicides (Ervin et al. 2000). Farmers thereby achieved greater flexibility in coordinating weed control with other required crop production tasks. Finally, because the most common herbicide for which resistance has been engineered in several crops is glyphosate (Roundup™) there is no concern about carryover to succeeding or rotational crops. Glyphosate is not environmentally benign but it is one of the most environmentally favorable herbicides ever developed and is much more so

than the herbicides that had been used for weed control in what are now called Roundup Ready™ crops. It is rapidly and completely adsorbed to soil, has only contact activity, and no soil residual activity. It degrades rapidly with a field half-life of 47 days (Ahrens, 1994).

In short, biotechnology has developed rapidly and is nowhere near reaching its potential. Scientists have not been working in the field long and it takes time to develop and bring good things to market. "The potential upside of genetic modification is simply too large to ignore—and therefore environmentalists will not ignore it. Biotechnology will transform agriculture, and in doing so will transform American environmentalism" (Rauch, 2003). Rauch does not deny that it includes risks but claims, without identifying them, that traditional cross-breeding does also. Government regulation is required so the risks (gene escape, invasive or destructive species) can be anticipated and controlled. However, the benefits far outweigh the known and unknown risks. Rauch (2003), echoing Avery (1995) and Waggoner (1994), suggests we might be able to grow all the food the world needs while reducing the human ecological footprint, returning cropland to wilderness, repairing damaged soils, and restoring ecosystems. The poor in the world's developing countries will be poorer if the current hysteria of the environmentalists is allowed to prevail (Degregori, 2002, p. 119). Agriculture in the world's developing countries must be improved but it does not have to be modernized, in the sense that it must become more like the presently unsustainable systems of the developed world (Chrispeels, 2000). If developing country agriculture can be improved, with biotechnology's help, and skip the high input, chemical and energy intensive system of the developed world and proceed to a truly sustainable system, that will be a good move that all can applaud. Biotechnology will do much to satisfy what Fedoroff and Brown (2004, p. xiii) cite as the challenge of the coming decades: "To limit the destructive effects of agriculture even as we continue to coax more food from the earth." In their view, that task is made less daunting by the new knowledge of genetic modification and new methods—if we use them wisely. They see molecular approaches to plant and animal modification (improvement) as the best way to increase food production in an environmentally responsible way.

A good test of the acceptance of genetic modification is farmer use. The Economist (2004b, p. 64) reports that the notion that the world's farmers have to be coerced, deceived, or bribed to grow GM crops is demonstrably false. In 1997, the world grew 1.4 million hectares (ha) of GM cotton and 7.2 million ha in 2003. China authorized commercial planting of GM cotton in 1997. Chinese farmers grew 1.5 million ha in 2001 (30% of the total cotton area). India, a major world cotton producer authorized GM cotton in 2002. Only 100,000 ha were grown in 2003–04 but that is expected to triple in 2004–05 (Economist 2004b, p. 64). When farmers see a clear benefit in dollars, yuan, or rupees, they rapidly adopt new technology including GM crops.

ARGUMENTS OPPOSED TO AGRICULTURAL BIOTECHNOLOGY

The case against is more nuanced than the case for agricultural biotechnology. This could be because many of the arguments in favor are promises of what is to come and those against are fears of what may already be. It could be as Degregori (2001, p. 112) claims, that it is hard to use the scientific method to create public understanding of complex issues when one faces opposition from "skilled propagandists working for strongly motivated ideological groups." His claim implies that everything about biotechnology is a scientific issue and can be addressed and reconciled with scientific data. His view is typical of the arrogance of scientists who view all issues as scientific and claim that the science that supports their view is sound while the science others use is bad (flawed) science (Kirschenmann, 2003). Perhaps the case against is as simple as the apparent fact that we humans often find it easier to be against something new than to develop strong persuasive reasons to be for it.

It could be that opposition stems from a loss of public faith in science because in spite of all that science has brought us, it also has often failed. The public's suspicion of science began with Carson's (1962) *Silent Spring*, a carefully documented, thoughtful, passionate polemic against pesticides. The public's suspicion has been reinforced by the agricultural community's defense of pesticides of all kinds and the claims that they did not harm wildlife or contaminate the environment when used according to label directions, until they had to admit pesticides did both. Agribusiness firms claimed and still claim that when pesticides are used in accordance with label directions they will not contaminate food, but they do. When nitrates were found in groundwater at harmful levels, the agricultural community claimed the source could not be fertilizer, but it was and is. Such agricultural claims were only reinforced by the more general suspicion of science that resulted from concern about thalidomide, antibiotics in meat, the herbicide atrazine in surface and well water, groundwater mining for irrigation, the effect of chlorofluorocarbons on the earth's protective ozone layer, and the link between mad-cow disease and Creutzfeldt-Jakob disease in humans (Kirschenmann, 2001).

Critics are aware that most (not all—see Wambugu, 2000) of the biotechnology products now available to the agricultural market are designed to enable producers to come closer to physiological yield ceilings, not to raise them (Ruttan, 2001). Available products can also be characterized as product protecting or market extending techniques rather than plant or animal physiological innovations. Many claim that if one truly wants to feed the world, it can be done best by using traditional plant breeding, improved soil and crop management techniques (Ruttan, 2001), integrated pest management systems designed for specific ecological and cropping systems, and some of the presently available GMOs (e.g., see Bray, 1994; Altieri, 2000). In short, a lot of yield enhancement can be

accomplished with what is already known and a new technological solution is neither required nor the best way to spend limited resources. Biotechnological solutions may be good, appropriate solutions to production problems but they are, by definition, technical solutions to the task of feeding people. The best solutions to hunger problems, especially in developing countries must include technology but they must also consider underlying social and economic problems that may be the true causes of hunger (Altieri, 2000). For example, Lappé (2002) claims that hunger is "not caused by a scarcity of food but by a scarcity of democracy."

It could be true that those opposed to agricultural biotechnology are indeed simply antiscience zealots (Borlaug, 2001) and skilled propagandists who use scientific evidence only when it supports their cause (Digregori, 2001, pp. 112–113). What are the elements of the case against biotechnology in agriculture?

Opposing arguments can be fairly characterized as progressing through three phases of what Thompson (1987) calls uncertainty arguments. The first phase raises a succession of doubts about the safety of the practice itself. Secondly one finds arguments that raise doubts about the reliability of methods for assessing risk. Finally, opponents question the motives, integrity, and reliability of scientists (the goodness of the characters) who have conducted risk analyses. Without evaluating the claims made, these kinds of arguments are illustrated in several portions of Bailey and Lappé (2002) and in Altieri (2001).

The arguments against agricultural biotechnology can be summarized in a few headings. They include claims that agricultural biotechnology:

1. Cannot feed the world and may not even help to do so.
2. Is likely to harm human health.
3. Will harm the environment in one or more ways.
4. Is another in a series of technological solutions that will not lead to a sustainable agricultural system and will have negative ecological effects.

Feeding the World

The transgenic crops that have been created have not been created to feed the world. They have been created because they were patentable and would improve profits (Lovins & Lovins, 2000). Nature has not been used as a model. Nature is viewed as a place over which we have dominion and it is our charge to subdue it and make it productive (see White, 1967). It is our task to improve nature, not learn from it. There will be disadvantages but technical skill will solve those problems as they arise as it has in the past. Science will march on. Lovins and Lovins (2000) argue that our technical ability has evolved much faster than the social institutions required to deal with technical advances. In their view, "skill has outrun wisdom." There is growing evidence that transgenic technol-

ogy has not increased farmer's yields or profits in developed countries, improved food quality, or improved the environment (Cox, 2002). Cox also claims, based on unpublished data from Goodman and Carson of North Carolina State University, that development of transgenic plant varieties is much more expensive (perhaps up to 10 times) than traditional plant breeding. It is, in his view, "not equipped to solve complex problems." Not only is it unlikely that transgenic technology will feed the world, it is highly likely (Cox, 2002) that its ascendancy and higher costs will lead to the destruction of traditional plant breeding programs that have fed the world. The most common available genetic modification is one of several herbicide resistant crop cultivars. The dominant one is Roundup Ready™ technology from Monsanto, mentioned above among the arguments in favor of biotechnology. Concerns include the transfer of the resistance trait to related weedy species that could then become more vigorous competitors simply because of the absence of other weedy competitors. Many call these plants superweeds but they are not super in the sense of uncontrollable. They are resistant to the herbicide to which the crop is resistant but they are not resistant to other common control techniques such as cultivation or other readily available herbicides. This does not mean that engineered resistance will fail. It does mean that farmers will once again have to rely on the approach known as integrated weed management rather than on one herbicide to do all weed management. A related objection is that while the herbicides for which resistance has been engineered are comparatively environmentally benign, other companies, to maintain or increase market share, may use genetic engineering to create resistance to herbicides that are much less environmentally favorable. It is also claimed (Hindmarsh, 1991) that the incorporation of genes to create pest (insect or disease) resistance will inevitably exert strong selection pressure that favors that small segment of any pest population that is naturally resistant to the incorporated toxin. As experience with chemical pesticides has shown, this is undoubtedly true. The claim is that such selection will, because of more rapid adoption and widespread use of the resistant cultivars, cause pest resistance to occur more rapidly. This means that the technology will fail more rapidly and more technical fixes will be required to solve the problems the technology caused. The technological treadmill will have to go faster just to keep up. A common response of the technological optimists is that the new genetic techniques will permit alteration of the genes themselves to make the toxin more effective (Hindmarsh, 1991). One is sure this will be possible, if it has not already been done.

Altieri (2000) and Altieri and Rosset (1999) argue that the claims of the proponents of genetic engineering in agriculture that it will increase world food productivity, enhance food security for all, and reduce dependence on chemicals and thereby reduce agriculture's environmental problems are false. The basis of their claim is that the world's food problems are not due to a lack of food but to poor distribution of presently adequate production. They see serious environ-

mental risks, little chance of helping small farmers in developing countries, and an increased dependence on pesticides, none of which, in their view, will lead to a sustainable agricultural system. Farmer's costs will rise because large, multinational seed and chemical companies will control the supply of both. Initially production systems that include herbicide or insect resistant crops may well be simple and lead to lower costs, but Altieri and Rosset (1999) project that ecological problems and pest resistance will follow and make such systems less attractive, more expensive, and less sustainable. They conclude that available agroecological approaches can solve the problems biotechnology says it will solve "in a more socially equitable and in a more environmentally harmonious manner." Altieri and Rosset (1999) do not deny that biotechnology can solve problems but insist that such solutions are not required because other more ecologically appropriate solutions are available or can be developed easily.

The high yielding varieties and new production system of the Green Revolution were created by public agencies with public funds and the results were made available without cost to national agricultural programs for further development and local adaptation (Chrispeels, 2000). The biotechnology revolution has been created largely in the private realm by agribusiness companies and their association with university researchers. The development has been done by large, multinational corporations that sell seed and pesticides that are directly linked to new biotech products. Patenting and the fact that it is not in the immediate interest of any multinational corporation to develop products that won't lead to improved sales and profits means widespread public benefit is not an immediate or obvious goal as it was in the publicly funded Green Revolution. Therefore, most of the transgenic work has been done by large corporations but not on crops of importance to developing countries where profit potential is limited or non-existent. Multinational corporations are not primarily aid-giving organizations and the direction their research has taken is not surprising. However, one does wonder how transgenic research will benefit the world's poor.

This view is in sharp contrast to that of Wambugu (2000) who argues that GM technology can mean higher yields for Africa and could literally weed out poverty by reducing the need for women to weed crops by hand. GM crops will increase food productivity by reducing pest problems and that will make Africa more self-sufficient and bring down the price of food. She advocates that the work must be done by local scientists who understand the need and the culture. Ability is not in question, capability with limited resources is.

Golden Rice, discussed above, was created to address the fact that many people, including many children, go blind or die each year in the world's developing countries because they do not have enough Vitamin A in their diet. In contrast to the TIME article by Nash (2000), Pollan (2001) calls Golden Rice the great yellow hype. Pollan (2001) argues that Golden Rice offers much more promise to biotech companies than it does to the world's rice-eating poor. This

is another case where it is too early to know for sure. Golden Rice has been created and scientists are now working to incorporate the trait for production of β carotene into other rice cultivars that have desired yield, texture, and olfactory characteristics that are so important to rice eaters. There is also exploration of a way to make Golden Rice white, which would make it more appealing to those for whom rice must be white. These new varieties have not been released to farmers, thus it is too early to tell how great or small their contribution may be. In any case, Golden Rice cannot be a complete solution to Vitamin A deficiency in diets of poor people. The average Asian adult rice eater may consume 300 grams of rice each day. That much Golden Rice will provide 8% of the recommended daily intake of Vitamin A. Obviously it cannot solve the problem, it can only help. The advantage to the biotech industry is clear. It is however, a product that will directly help people rather than just make a plant resistant to an herbicide or able to provide its own insect control. Pollan (2001) suggests Golden Rice is a solution to the industry's public relations problem. Others (Altieri, 2000; Altieri & Rosset, 1999) argue that Golden Rice is not a solution at all. The solution, in their view, is to teach people the benefits of eating what is already abundant—wild and cultivated leafy greens rich in Vitamin A. These things are not part of the Asian peasant's diet but yellow rice is not either (white rice is). One will cost money, the other while not free, is available at a much lower cost.

Harm to Human Health

The U.S. regulatory system combines the following:

1. The USDA through the Animal and Plant Health Inspection Service (APHIS) to determine agricultural and environmental safety of proposals for field evaluation of genetically modified organisms,
2. The EPA charged with assessing environmental risks through its mandate to regulate pesticides, and
3. The FDA which is responsible for the safety and labeling of all food and animal feed (Thompson, 2000).

Each agency uses a science-based approach, which means that a transgenic crop will be approved for the market (it can be sold, planted legally, and consumed) if there is not firm scientific evidence that it causes harm. In contrast, the European Union (EU) has adopted the precautionary approach that maintains that a transgenic plant can only be approved for the market if there is firm scientific evidence that it does *not* cause harm. The difference is that in the U.S. a transgenic product is innocent until proven guilty and in the EU the opposite is true. The latter is a much more demanding standard. The EU process shifts the burden of proof from the government regulatory agency (in the U.S. it must prove harm to deny an application) to the applicant (usually a private firm, which

must prove no harm and establish benefit) (Buttel, 2003). The EU process also rejects the concept of substantial equivalence that holds that "if a new or modified food or food component is determined to be substantially equivalent to an existing food, then further safety or nutritional concerns are not expected to be significant" (Organisation for Economic Cooperation and Development, 1993). The EU also has a social impact standard that goes beyond the regulatory criteria of product efficacy, human safety, and environmental and non-target species safety that are accepted by the EU and the U.S. (Buttel, 2003).

Criticisms of the U.S. regulatory system (Ervin et al. 2000) focus on four major deficiencies:

1. The need for more participation by ecological scientists.
2. An environmental agency (not an agricultural agency) should be the lead agency for ecological assessment.
3. The entire process should be more transparent to the public.
4. Values and socioeconomic criteria should have equality with scientific criteria.

A value driven system of evaluation would tend to focus on questions of public welfare including human and environmental questions, relative benefits and risks, and appropriate caution (Bailey, 2002a; Buttel, 2003).

Perhaps the essence of the claims surrounding possible harm to human health is that consumers now do not have a choice and ought to. It is clear that Americans and Europeans are both concerned about their health and ways to protect it now and in the future. Ecological effects are important in both cultures and there is a rising concern about the ever more dominant links between industry, government, and academia. Over all of these shared concerns one must recognize the very different cultural and historical forces that exist and help to explain the different reactions to GMOs in the two cultures.

There is no question that people's health can be affected by what they eat (e.g., malnourishment and resultant obesity due to eating too much of the wrong food in developed countries) and by the fact that diets that are inadequate in basic nutritional needs lead to poor health. The potential for allergic reactions in people exposed to new proteins in genetically modified food is of concern to many. If I do not know the origin of what I am eating how can I avoid eating what may be harmful to me? To date there have not been any incidents of allergic reactions to genetically modified food. This is not because of blind luck on the part of those who genetically modify food. The lack of incidents is because scientists have progressed in identifying and categorizing protein allergens (Fedoroff & Brown, 2004, p. 189). Allergenic proteins are usually abundant in a food, survive cooking, are quite stable, and resist metabolism by stomach acids (Fedoroff & Brown, 2004, p. 189). There are several examples of modification projects that have been stopped because allergens were looked for, noted, and when present caused the project to be stopped or altered. The potential negative health effects of an allergen unknown to the consumer is not debatable.

Health, it is claimed, can also be affected negatively if there is an inability to choose what one wants to eat. There are many sets of guidelines designed to assist people in choosing a healthy diet. However, if it is not possible to tell what one is eating because the product is not completely labeled, some element of free choice has been eliminated and that bothers many people. The relevant question is not is the food safe, it is do I want to eat this food? Thompson (2002) points out that for many people, eating is not just an instrumental act (I must eat to live), it is a spiritual act that ties one to the material world. For some, eating is a sacramental act, a religious rite. One does not just eat, one must eat correctly and give thanks.

One of the basic tenets of a democratic society is that the citizens must be consulted; they have a choice about how they are to be governed and how the society is to be managed. In a democratic society the citizens are not subject to the whim of a dictator, they are consulted because their opinions matter. What one eats ought to be a matter of choice and the decision is not purely scientific, wherein peer-reviewed science (Thompson, 2002b) establishes that a food is substantially equivalent to another food and therefore it is OK for anyone to eat it. Citizens of a democracy are quite sure they have certain inalienable rights and choosing what they want to eat is among them. If I don't want to eat at a fast-food hamburger place because I think (I could be wrong) that such food is harmful to my health, I don't have to. I can, in Thompson's (2002b) words, opt out of that choice. It is my right to be able to opt out. With transgenic crops and animals there is no ability to opt out because such products are not labeled. The European Union's regulators regard labeling of all transgenic foods as the right measure to protect public health and choice, whereas the U.S. opposes labeling as being too costly and impractical (see Hileman, 2002, pp. 125–126; Sherlock & Morrey, 2002, pp. 187–189; Halloran & Hansen, 2002). Proponents argue that labeling is not required because the products are not different; they are substantially equivalent. They may be right, but I may still want to be free to choose what I will eat and I cannot if it is not labeled. As Thompson (2002) correctly notes, "the right of exit is a necessary condition of a just society." The right does not extend to a personal ability to demand that my society provide me or anyone else with anything we may want. But if I am required to do what I may not choose to do because the freedom of choice has been taken away, that is a moral wrong. The right of exit, the ability to opt out, should not demand that all produce scientific evidence of no danger. The right means only that as a citizen of a democratic society we all have been given the privilege to choose based on religious, political, and cultural considerations and these need not be based, indeed, by definition, cannot be based on scientific evidence. The freedom to choose is fundamental in a democratic society and a refusal to label based on scientific evidence that may be unknown to consumers, not understood if available, or unavailable, denies that freedom.

Harm to the Environment

Most transgenic crops (71%) have been planted in the U.S. with an additional 17% in Argentina, and 10% in Canada (Ervin et al. 2000). Ervin et al. (2000) claimed that 40 transgenic crops had been planted in eight developed countries and four developing nations. More than 20% of the acreage was soybeans. In addition to development of resistance to a pesticide, other potential risks include uncontrolled gene flow via pollen transfer to wild relatives, transfer of incorporated resistance (herbicide, insect or disease) to wild relatives or weeds from the same genus, gene transfer to microorganisms, a reduction of *in situ* crop genetic diversity, dispersal and invasion of GM plants into ecosystems, and potential adverse effects on unrelated, perhaps beneficial, non-target organisms (Ervin et al. 2000; Kremer, 2004). Few large-scale field studies have been done to evaluate and verify these risks. Firbank and Forcella (2000) did a careful study in the U.K. and Minnesota to ask if genetically modified crops affected farmland biodiversity. They accepted that normal farming practices have led to a decline in farmland biodiversity, especially in the U.K. The advent of genetically modified crops has led to a decrease in weed diversity but some weed species escape control by germinating after a contact herbicide has been applied and others are somewhat tolerant of the herbicide. Firbank and Forcella (2000) studied weed seed production as it might affect bird populations. They concluded that "it is simply too soon to tell." Their conclusion justifies some of the fear of those who object to GM technology, that there has not been enough time to determine the risks. Answers to important questions, such as effects on wildlife, can not be obtained quickly.

A recent report (not a published. peer-reviewed scientific study) supports the argument that it is too soon to tell what may happen. The essence of the report (Spotts, 2004) is the radical concept that a gene or a set of genes from a single species can affect an entire ecosystem. That is, individual genes can have major effects on communities and community composition. A few examples support the general hypothesis. Schweitzer et al. (2004) reported that differing condensed tannin concentrations are genetically based and are the best predictor of ecosystem-level processes. Condensed tannin inputs from foliage of different types of cottonwood trees explained 55 to 65% of the variation in soil net nitrogen mineralization. They concluded that plant genes had "strong, immediate effects on ecosystem functioning." Bailey (cited in Spotts, 2004) showed that beavers, who are well known for creating landscapes, showed a preference for cottonwoods, determined by tannin concentrations—the lower the tannin level the more beavers liked the wood. Wimp et al. (2004) showed that the genetic diversity in cottonwoods, a dominant riparian species, affected the arthropod community composed of 207 species. Cottonwood genetic diversity accounted for nearly 60% of the variation in arthropod diversity and effectively structured

arthropod diversity. Whitham et al. (2003) presented evidence that the heritable genetic variation within dominant or keystone species has community and ecosystem consequences. Their work demonstrates what Whitham et al. call "extended phenotypes." They propose that there can be an effect of genes on system organization at levels higher than the population. They demonstrated community heritability. These studies suggest that the greater the genetic diversity in individual cottonwoods, the greater the diversity in the insect community associated with a given tree. A reasonable conclusion is that individual genetic factors may have a more pronounced effect on communities than was heretofore believed. It thus follows, although it has not been proven, that while an inserted single gene for herbicide or insect resistance is one among millions in a complex ecosystem, it still may have profound effects. As Firbank and Forcella (2000) noted, it is too soon to know what the effects may be or what they may mean for ecosystem stability.

The Ervin et al. (2000) report concludes that if biotechnology is to achieve its full potential for environmental benefit and avoid human or environmental catastrophe, national and international governmental regulatory oversight is required. They recommend a "cautious approach" that includes two elements. The first is the necessity of increased investment in public research and development that, in their view, will ensure that the "neglected environmental aspects of transgenic crops receive adequate attention." It is their view that public investment will lead to a "comprehensive monitoring system" that will achieve proper evaluation of the crops and their environmental effects. Private companies do not have incentives to invest in public goods (e.g., adequate street lighting in urban areas, mass transit systems) and will not do so unless coerced. Investment in public goods does not increase profit or return to stockholders. Public research and evaluation is required if public rather than private good is to be maximized.

Secondly, the Ervin et al. (2000) report advocates a change in the U.S. regulatory process and in the governing agencies. They claim that there are many demonstrable shortcomings of the present three agency system. There are gaps in regulatory coverage and a failure of the agencies "to conduct comparably rigorous reviews with original scientific data." Environmental scientists, their data, and their perspectives are often just left out.

A frequent objection is that the release of a transgenic organism into the environment is especially dangerous because the organism cannot be recalled. Plant escape via seed movement, pollen transfer, or intentional or unintentional human intervention is inevitable. Once an organism escapes, given nature's complexity, one cannot predict what will happen. Will ecological diversity be affected? Will an organism be more ecologically fit and become a serious pest or will it just die due to lack of fitness? One cannot always know, so caution is wise. As Commoner (2002) points out, "What the public fears is not the experimental science but the fundamentally irrational decision to let it out of the laboratory into the world before we truly understand it." When we think we understand, it is called

science. When one learns to use it, it is called technology and it is the frequently weak link between understanding and use that the public often fears. A report in *The New York Times* (Anonymous, 2004a) illustrates the concern. Genes from Roundup® resistant creeping bentgrass developed by Monsanto and Scotts migrate much farther than anyone had thought was possible. The initial estimate by Scott's scientists was pollen travel up to 1000 feet. Work by EPA scientists showed pollen travel to sentinel plants of the same species as far as 13 miles and to wild relatives nearly 9 miles away. The concern is that the herbicide resistance genes may spread to wild relatives and complicate the task (i.e., may make it impossible) of controlling weeds with Roundup® herbicide in many landscapes.

When transgenic plants are demonstrated to be substantially equivalent (see section on regulation above) it is not required that the applicant show that the plant "actually produces a protein with the same amino acid sequence as the presumably inserted protein" (Commoner, 2002), although this does not seem to be an unreasonable regulatory request. If the plant behaves as predicted or desired (it expresses a Bt protein or resists glyphosate) then it is substantially equivalent, even if not precisely described. Commoner's (2002) objection points out the implicit assumption that it is a plant's (or any organism's) genome, its DNA as expressed in its genes, that determines what it is and how it will behave. Much of its nature is determined by its DNA not by its nurture or by its environment. Molecular biologists have what Commoner calls a false central dogma: "molecular structure is the exclusive agent of inheritance of all living things." The dogma ignores nurture and the environment and their role not in gene creation but in gene expression.

Neither side has good, long-term evidence but both have a view on environmental release of transgenic organisms. Proponents argue that the risks are negligible and largely the creation of environmental groups that support their opposition by creating public fear (e.g., Hindmarsh, 1991, p. 200). Critics suggest that there may be pandemics caused by widespread release of created pathogens and the possible creation of major ecological imbalances. Available evidence compiled in a study by the Council for Agricultural Science and Technology (CAST, 2002) suggests that the commercialized corn, soybean and cotton cultivars yield environmental benefits and are not environmental problems. The improved insect, disease or weed management obtained is "consistent with improved environmental stewardship in developed and developing nations" (CAST, 2002).

A concern of those opposed to biotechnology is the potential for loss of genetic diversity as genetically modified crops occupy more and more of the world's arable land. Ecologists are sure that large monocultural areas are ideal environments for large scale infestations of insects, diseases, and weeds. Large monocultures also create the risk of the loss of genetic diversity as farmers abandon traditional varieties to adopt the new. The claim is the same as that which followed widespread adoption of Green Revolution varieties in the 1960s. The risk is loss of the genetic diversity, which cannot be recreated, once lost.

The international crop research centers of the CG system (Consultative Group for International Agricultural Research, e.g., IRRI—International Rice Research Inst. in the Philippines and CIMMYT—Centro Internacional de Mejoramiento Maiz y Trigo, in Mexico) each has a responsibility to preserve germplasm found in traditional varieties and each has done so. Thus, this claim is valid in that large monocultures are at risk for large scale pest infestations but the claim has less validity in the sense that traditional germplasm is being sought and preserved whenever possible. Even though such varieties may not be regularly planted the unique germplasm has not been lost. Skeptics worry that control will pass from developing countries, where much of the germplasm is found, to multinational corporations that will find just the genes they need to make yet another modified crop and then sell it to farmers in the country from which the gene came. This is entirely possible but the issues raised are not simply questions about biotechnology. They are scientific (do those who create new varieties, have so called "breeders rights"?), political (who controls germplasm?), and moral (who ought to control germplasm?) questions.

Transgenic Technology and Sustainable Agricultural Systems

One of the clear examples of widespread, rapid adoption of transgenic technology is the use of herbicide resistant crops (HRCs), especially in the U.S. For example, there were more than 1000 glyphosate resistant soybean cultivars available in the U.S. in 1999 (Lawton 1999); the rate of farmer adoption of herbicide resistant crops was very rapid. It is likely that the acceptance and rapid adoption of HRCs and the attention they receive by weed scientists will delay development of non-chemical weed management techniques (Duke 1998). The University of Nebraska Agbiosafety Web site (http://agbiosafety.unl.edu/education.shtml) reported in June 2004 that 17 crops had been genetically modified with 73% receiving a gene from an external source. Nearly all of the genetic modification was done to achieve herbicide or insect resistance. These crops have created new, still chemically-based, farming systems that have increased reliance on certain herbicides as they inevitably force development of resistance to those herbicides. HRCs have led to outcrossing of the resistance trait to weeds, a change in the spectrum of weeds to be controlled, the development of tolerant crops and the need for new techniques to manage resistant crop volunteers. If a sustainable agricultural system is to be achieved (see Chapter 7), many feel it cannot be done by continuing to follow the path of the present chemical, energy, and capital dependent system that has caused so many of today's agricultural problems. HRCs, being more of the same kind of technology, won't lead to sustainability, they will only lead to more problems.

Radosevich et al. (1992) linked biology, technology, and ethics to frame questions about HRCs early in the technology's development. They proposed that if

such questions were addressed early, the technology would have a more solid scientific and moral foundation. Martinez-Ghersa et al. (2003) revisited the same questions 10 years later to determine their current relevance. They found that after a decade of development, HRCs (which the earlier paper called Herbicide Tolerant Crops, HTCs) had not increased crop yield, had made weed management simpler (more efficient), but had not significantly reduced weed management costs. There has been uneven adoption of the technology around the world due to rejection of the technology by some countries and the resistance of agribusiness to invest in countries where their intellectual property rights are not protected. Martinez-Ghersa et al. (2003) conclude that there is still insufficient ecological information available to affirm that there is or is not ecological and agricultural harm from use of HRCs. Science is still not certain about answers to questions concerning development of herbicide resistant weed populations, the development of so called superweeds in other crops, transfer of inserted genetic constructs into wild relatives, and the long-term effects of reduction in species diversity on agroecosystems. In the moral realm, the answer to the questions of who really benefits from and who or what may be harmed by the technology is still uncertain (Martinez-Ghersa et al. 2003). The need for continued ethical discussion exists although it and new biological questions (production of allergens or toxins, genetic erosion, effects on non-target organisms) are often secondary in the continued testing and release of new HRCs.

Herbicide resistant crops allow farmers to use reduced or no-tillage cultural practices more effectively, to eliminate use of herbicides that are more environmentally harmful than glyphosate and glufosinate, which are not the only, but are the most common herbicides to which resistance has been created. They are both applied postemergence to the crop, non-selective herbicides that have minimal environmental effects. It is recognized that continued use of any herbicide will cause weed population shifts and speed the selection of resistant weed genotypes. Development of resistance in natural weed populations was hypothesized by Gressel and Segal (1978), but there were no reports of glyphosate resistance in 1992 (Radosevich et al. 1992). Now (as cited in Martinez-Ghersa, 2003) resistance has been confirmed for rigid ryegrass (*Lolium rigidum* Gaudin) in Australia (Powles et al. 1998), goosegrass [*Eleusine indica* (L) Gaertn.] in Malaysia (Dill et al. 2000; Lee, 2000), horseweed [*Conyza canadensis* (L.) Cronq.] in Delaware (VanGessel, 2001), and common waterhemp (*Amaranthus rudis* Sauer) in the mid-western U.S. states (Pringnitz, 2001). Velvetleaf (*Abutilon theophrasti* Medicus) tolerance to glyphosate has been reported in Iowa (Owen, 1997).

Although incorporation of herbicide resistance in crops has permitted control of many previously recalcitrant weed species there is concern among weed scientists about evolution (selection for) of resistance to presently useful herbicides and population shifts to naturally resistant weed species. There is also concern about gene flow from resistant crops to wild relatives or closely related species. This may not be an important problem (Gressel, 2000), but it is one that should

not be ignored. Because several major crops do not have close relatives in the areas where they are grown (e.g., corn, soybean, cotton) whereas others do. For example, canola is related to several species of *Brassicaceae* weeds, potato is in the same family as *Solanaceous* weeds such as black nightshade (*Solanum nigrum* L.) and other nightshades, wheat shares part of its genome with the now common weed jointed goatgrass (*Aegilops cylindrica* Host), and rice interbreeds with the common rice weed, red rice (*Oryza sativa* L.) (Langevin et al. 1990). Glufosinate resistance has been transferred from rice to red rice (Sankula et al. 1998). However, the problem may not be important if genetic modification does not confer an ecological fitness advantage outside the fields where the weed and crop co-exist (Duke, 1998).

Biotechnology is relatively new in weed science and although HRCs have been rapidly adopted much is still to be learned about the effects of this powerful new tool on weed science and weed management techniques (Duke, 1998). The science has been market driven to develop transgenic crops that allow use of broad spectrum herbicides that will contribute to corporate profit (Gressel, 2000). To date, not much has been done to use the potential of biotechnology to develop weed control methods that are not dependent on chemicals. This could be done by enhancing crop competitiveness for nutrients, light, or water or by exploiting natural allelopathy (Gressel, 2000). Gressel also suggests that biotechnology could be used to modify weed populations to make them less competitive and to make hypervirulent biocontrol agents that are safe but not able to spread. These innovative ideas show biotechnology's potential but such achievements may only occur when biotechnology research is publicly funded rather than profit driven. Profit is not evil, but the quest for profit inevitably leads research in directions that may not be environmentally, socially or politically desirable.

van den Belt (2003) claims that GM crops have become a symbol for "all that Europeans don't like about modern agriculture." He agrees with Hileman (2001) that the European debate is neither simply emotional nor about food safety, it is about how farming should be done (Hileman, 2001). The biotech food debate is a proxy for a larger debate about how agriculture should be done. Europeans view biotechnology as something that may destroy wilderness and the natural environment (as exemplified by farmland) as they know it (Hileman, 2001). Gould (1985) characterized the debate well. He contrasted the "immediate and practical" with the "distant and deep" issues. Immediate and practical issues included concern about "potent and unanticipated effects," many of which are mentioned above. Distant and deep concerns are clearly the EU focus. They ask, as Gould (1985) does, "What are the consequences, ethical, aesthetic, and practical, of altering life's fundamental geometry and permitting one species to design new creatures at will, combining bits and pieces of lineages distinct for billions of years?" Gould and the EU are not campaigning for abolition but rather for proper development and use.

THE MORAL ARGUMENTS

Moral claims are clear in the agricultural biotechnology debate, but while a moral foundation of arguments is always present it frequently is subsumed and not apparent in the flurry of competing empirical claims.

To illustrate the problems with questions of what one ought to do, I turn again to the wisdom often found in the Calvin and Hobbes cartoon series by Watterson (1993).

The cartoon opens with Calvin filling a balloon with water.

Calvin says, "In order to determine if there is any universal moral law beyond human convention, I have devised the following test."

"I will throw this water balloon at Susie Derkins unless I receive a sign within the next 30 seconds that this is wrong."

Calvin pauses to note that—"It is in the universe's power to stop me. I'll accept any remarkable physical happenstance as a sign that I shouldn't do this."

"Ready . . . Go!"

Calvin looks up and says, "Nothing's happening, five seconds to go!"

Calvin streaks away in search of Susie, saying—"Time's up. That proves it. There is no moral law!" Wheee!

With a look of vicious glee, Calvin hits Susie on the head with the water balloon.

Susie immediately races after the retreating Calvin who screams for help.

In the last segment, Calvin lies smashed on the ground with stars swirling about his head, and laments, "Why does the universe always give you the sign AFTER you do it?"

The cartoon clearly states the case for those opposed to the rapid adoption of agricultural biotechnology simply because we can do it.

For many people the morality of biotechnology must deal with the risk of playing God. That is, there are some things humans are not supposed to do, especially as Calvin points out, when we don't know or cannot anticipate the consequences. Prometheus was not supposed to give us fire and Pandora was not supposed to open her box. Other people are concerned about possible effects on human health, the health of other species, or the environment. Many questions seem to be empirical: Are GMOs safe to eat? It is important to understand the question being asked and the value positions held by the questioner and those who answer. There are many important moral issues that have been dealt with well in other places (e.g., Bailey & Lappé, 2002; Comstock, 2000b; Gendel et al. 1990; Kneen, 1999; Sherlock & Morrey, 2002). For the sake of brevity and without any pretense of presenting complete moral arguments, I conclude this chapter with five important, unresolved moral questions:

1. labeling,
2. affects on family farms,

3. academic-industry relationships,
4. transgenic pharming, and
5. the precautionary principle.

Labeling and Biotechnology in the U.S. and the EU

The EU has mandated labeling of any agricultural commodity containing at least 0.5% GM content or less. U.S. developers and regulators have opposed labeling and expressed regret over the EU's more restrictive stance which will affect the annual $6.3 billion EU market for U.S. agricultural commodities. Both positions are shifting (Pew Initiative, 2003). The EU appears ready to approve corn modified with the Bt gene for consumption (consumers can eat it when imported) but not for production (farmers can not grow it) (Meller & Pollack, 2004). A significant portion of the argument centers not on dangers to human health but on danger to wildlife. In the U.S. approximately 28% of the land is cultivated, and one can find abundant farming and separate wildlife habitat. In Europe farming and wildlife are intimately linked because, for example, in the U.K. 80% of the land is cultivated (Williams, 1998). Because enough studies have not been done to determine the effect on wildlife, caution is demanded before widespread adoption of transgenic crops is allowed. A risk is that by being too cautious, European companies and scientists will fall far behind in the world competition for the potentially huge market. On the other hand, Monsanto, a major developer of transgenic crops, announced that it would not market the world's first herbicide (glyphosate) resistant wheat because of opposition, not from the EU, but from American and Canadian farmers who feared losing billions of dollars in export earnings because European and Japanese consumers would not buy transgenic wheat (Pollack, 2004).

A common view among agricultural scientists is that there are nasty environmentalists who argue that risks that are presumed to be real but are not understood are alleged to threaten human health and diminish biodiversity. Even though the ensuing arguments frequently lack scientific credibility the debate has discouraged consumers from eating what some regard as perfectly safe products and led the food industry and transgenic manufacturers to abandon (i.e., Monsanto) promising technology. This common view misses many of the concerns that motivate public skepticism or outright rejection of biotechnology. The public concern does not always result from or is it alleviated by measurement of scientific risk. A risk-benefit analysis that is science-based often cannot address the concerns that result from non-scientific questions. The public issues are frequently moral and science based answers don't immediately address moral concerns. The moral concerns include such things as (Comstock, 1989):

- What are our duties toward the natural environment?
- What are our political and economic responsibilities?

- What are our ideals and attitudes about communities?
- Is it right to respect individual rights?
- Ought we to help the disadvantaged (i.e., residents of developing nations)?
- Can capitalism and technology enframe nature and eliminate our dependence on the natural world?

The questions are similar and can be summarized as—What is it that we ought to do?, a moral question. Given the increasing public suspicion of the morality of large corporations, of agribusiness, and the awareness of the economic and social power of large businesses (see Drutman & Cray, 2004), the democratization and transparency of biotechnology seems essential to gaining public approval and support (Strauss, 2003).

For any technical/scientific development issue some questions should be asked before commercial release, during the development process. For genetic modification in agriculture the five questions that should be asked are (Comstock, 2000a):

1. What agricultural problem does the genetic modification address?
   Does the genetic modification actually address the problem that proponents say it will solve? Biotechnology is a product of industrial capitalism that emphasizes private profit, short-term control of nature, and neglect of short- and long-term social and environmental consequences (Middendorf et al. 1998), if the latter are even acknowledged. Production increase is the problem commonly addressed even as other problems appear. Middendorf et al. (1998) suggest this is because we live in a society that has nearly absolute faith that all human problems will be solved by technological advances.
2. What harm may follow?
   What is the nature of the harm? Who will be harmed and how is the harm distributed among those who may be affected? Proponents of biotechnology emphasize the benefits of increasing the amount and quality of food available without dealing with issues of access to the food or its distribution to those who are hungry (Middendorf et al. 1998).
3. What is known?
   Scientific facts must be separated from scientific opinions and what is not known should be revealed.
4. What are the options?
   For most agricultural problems there is an array of alternatives in addition to biotechnology. All options should be explored and their relative advantages and disadvantages should be explored.
5. What are and what ought to be the guiding ethical principles? It is likely that the guiding ethical principles will be among those presented in Chapter 4. There is always a guiding ethical principle but it is frequently implicit and it must be made explicit.

The agricultural community has tended to focus on how agricultural biotechnology will increase production of agricultural commodities because increasing production is seen as the best, if not the only, way to feed a growing population. Secondarily the emphasis has been on efforts to improve the quality (nutritional composition, storability) of commodities, and on reducing the cost of food. Other groups, regarded as opponents of biotechnology by the agricultural community, have tended to focus on potential harm, what is known and not known, and other options. Questions such as what are the potential effects on human and animal health and about effects on environmental quality are primary. These groups also ask about the distribution of effects with questions about social justice and fairness to all stakeholders and the different implications of the advent of a technology on first and third world countries (Burkhardt, 2001). It is easy for either group to give primary emphasis to its important questions and dismiss or ignore other questions. Thompson (2000a) discusses the philosophical debates surrounding rational choice and informed consent with respect to the food we must eat. Advocates of biotechnology emphasize minimization of risk which they think is already minimal and can never be completely eliminated. The more cautious suggest that in a democracy, all have a right to choose what they will consume and an assumption of probable harm is sufficient to require labeling even if the likelihood of harm is, from a scientific perspective, very low. Proponents are confident that labeling will encourage poorly informed individuals to misinterpret labels and reject food that is not harmful. In Thompson's (2000a) view, GMO food, already feared by many, will be stigmatized by labeling, without any scientific basis.

For example, the developers of herbicide resistant crops have correctly pointed out the crop production benefits of greater simplicity and surety of weed control by using herbicides that if not environmentally benign are more environmentally favorable than the herbicides they replace. Moral questions about human duties to the natural environment, political and economic responsibilities to each other, and our obligations to future generations (Dekker & Comstock, 1992) have not been part of agricultural evaluation of herbicide resistant crops.

Affects on Family Farms

Burkhardt (2000) identifies three moral critiques of agricultural biotechnology that deal with possible effects on family farms. They are potential harm to (1) an important political-economic entity, (2) a cherished symbol if not the embodiment of basic American moral values, and (3) a solution to long-term natural resource problems. It is probably correct to say that the vast majority of the American public like family farms, support their continued existence, and, unless they have read Wendell Berry's *The Unsettling of America: Culture and Agriculture* (1977), have no idea what is happening to them. Most Americans do not know

that the idyllic family farms they envision, if they think of farms at all, are in deep economic trouble and are disappearing rapidly (see Halweil, 2004).

At the time of the American Revolution the vast majority of Americans were farmers. In 1900, 60% of the U.S. population was in rural areas and America had 5.7 million farms. According to USDA data, in 2001 America had 2.1 million farms and about 0.7% of the population was engaged in full-time farming (fewer people than are in U.S. prisons). Average farm size gradually increased to 436 acres in 2001. Nearly 1.5 million U.S. farms are less than 80 acres and are supported by day jobs held by men and women. That is, such farms are not viable economic entities, although each produces agricultural commodities, few make enough profit to support a family. Of these farms, around 1.3 million are part-time, residential, or retirement farms and more than 60% of retail farm sales are captured by 163,000 large farms. More than 60% of the large farms are bound in some value linkage with a large corporation and are not what one would define as a family farm. It is quite within the realm of possibility that as few as 25,000 commercial farms will remain in the U.S. by 2030. Corporate owners include petrochemical companies, restaurant chains, and urban investors (Burkhardt, 2000). Burkhardt posits that if the effects of industrialization (and biotechnology is another step in industrialization) were as apparent to the majority of the American public as they are to farmers and residents of rural communities supported by farming, U.S. agricultural polices that have led to the demise of family farms might change.

Biotechnology, another step in the industrialization of agriculture, is a further contribution to the forces that are destroying family farms. Therefore, while important moral questions should be addressed they seem to be insignificant when arrayed against the forces that impel the continued development of chemical, energy and capital intensive agriculture. From a political-economic perspective the question of whether or not policies should be developed to encourage the continued existence of family farms represents, in Burkhardt's (2000) view "a test of the fairness or justness of democratic, market-based societies." Similarly, from a cultural or moral-value perspective, Burkhardt wonders if the values (e.g., helping others, community life, responsibility, stewardship) associated with traditional family farms continue to be viable and if the survival of family farms may serve as a test of the moral or spiritual health of modern society. Finally, with regard to moral obligations to future generations, Burkhardt asks if the environmentally sustainable practices family farms have employed in the past can be employed in modern industrial farming and if this is a test of the legitimacy of current production practices. The family farm is what Burkhardt calls "a metaphor for the good life, ethically conceived," rather than simply something people do to make money. Biotechnology is business-oriented, materialistic and not supportive of the values inherent in family farms or of basic human needs (Burkhardt, 2000). The demise of family farms in the U.S. is a fact and many see it as an inevitable and not undesirable outcome of the quest for higher produc-

tion and efficiency. The family farm is viewed as an anachronistic entity that does not fit in the modern world. Family farms are economically inefficient and should be allowed to fade away because family farmers can not or will not adapt. In the U.S. the view is—that is just the way it is, get used to it!

That view is correct when the family farm is seen as simply an inefficient production enterprise. It should disappear just as the corner, full-service gas station and the Mom and Pop grocery store disappeared. They could not compete in a changing economic world. However, there is another view. Many European nations see family farms as we used to see them—as the backbone of valuable rural communities. They are not just production units, they are social and cultural units that have value. U.S. agricultural support policy rewards production, whereas policies in many European nations (e.g., Austria, France, Germany, and Switzerland) support people. It is a common European agricultural policy to regard family farms secondarily as production units. First they are essential components for maintenance of rural communities and rural life (see Goldschmidt, 1998). They are the key link in maintenance of rural communities (villages) which are regarded as important, if not essential, to maintenance of national cultural richness (Friedman, 1999, p. 239). Family farms are also supported because the farmers care for the land; farmers are stewards and are rewarded for their stewardship of the land. Their stewardship of the land is supported because, among other things, the farm landscape and the maintenance of the rural communities farms support assures that Austria will look like Austria is supposed to look when tourists arrive.

Academic-Industry Relationships

An early, influential publication raised ethical concerns about herbicide resistant crops and their threat to development of sustainable agricultural systems (Goldberg et al. 1990). The report emphasized the likelihood of environmental harm and what they regarded as inappropriate allocation of funds toward biotechnology and away from programs designed to develop sustainable agricultural systems. The report also was highly critical of Land Grant Universities that were vigorously pursuing biotechnology which, in the author's view, would primarily benefit large corporations and harm family farms (see Thompson, 2000c). Goldberg et al. (1990) claimed that development of herbicide resistant crops would not deliver what was needed: "an economically viable and sustainable agriculture that uses safe and ecologically sound pest management strategies."

Blumenthal and Campbell (2000) raised the same issue that Goldberg et al. (1990) raised. After several years it is still not apparent to many engaged in agricultural biotechnology that the issue of actual and potential effects of biotechnology research on the academic community is important. There is a long tradition of research cooperation and mutual benefit between the academic and industrial

communities. In the simplest terms, industry has been a source of funds and the academy has been a source of talent. Universities accept funds and research ideas from the industrial world and return research results and ideas, which often lead to profit based on the transfer of intellectual property from the academy. Industry funds were often restricted in that specific tasks and goals accompanied the money. Academic scientists frequently serve as consultants to industrial firms, an activity permitted and encouraged by universities. Beginning in the 1990s, government funding for universities began to decline. Some of this may have originated in the idea developed during the Reagan Presidency (1981–89) that those who benefit from such things as higher education ought to pay the costs. This was a departure from the older idea that higher education was beneficial to those who received it but was also beneficial to the entire society. All benefited as more became educated. This was part of the motivation for the large government expenditures on the GI bill after World War II that enabled returning military people to go to college. Now the costs of doing research are high, the equipment required to do science is very expensive, and Federal and State support for University research is declining. Scientists are compelled to spend a great deal of time and effort finding research support (often called, proposing to work), for without it they will not be able to publish and they will therefore, perish. Research funds are often easy to obtain from supporting industries (Blumenthal & Campbell, 2000). The funds come with specific goals and research directions and may also come with intellectual direction. That is the source of the funds determines what will be done and the academy thereby loses some of its independence concerning what research will be done. Perhaps the ultimate expression of this trend is when University research scientists start new companies and retain their university ties, and do complementary research in both places.

Blumenthal and Campbell (2000) identify several desirable ties between industry and public research institutions that have benefited society. Graduate student education has been facilitated by the money, sponsors have much more rapid access to research results, and technology transfer to industry is enhanced. The risk that is especially apparent with biotechnology is that industry sponsors may undermine the university's reputation for objectivity (Blumenthal & Campbell, 2000). The quest for external funding has increased as government support for higher education has declined. Rhodes (2001, p. 136) reported that California built 21 new prisons and one new university between 1980 and 2000. Its university system was once regarded as the best in the world, but the state now spends more to incarcerate its criminals than it does to educate its youth. The share of California's budget that goes to higher education fell from 12.5% in 1990 to 8% in 1997 while support for prisons increased by 4.5%, an amount equal to the loss in support for higher education. Similar examples exist in several U.S. states where declining tax revenues and fixed expenses have compelled cuts in the share of state funds available for higher education. The U.S. has as many prisoners as it has graduate students.

These things do not mean that good scientific research is not being done in universities. The trend may mean that the research may be applied to a short-term goal that enhances benefit to the supporting industry. There may be a reduction in scientific openness and more direction of research toward what is popular or can be funded rather than toward what ought to be done. This does not present any immediate threat to the conduct of science in universities or to the central educational mission (Blumenthal & Campbell, 2000) but it does raise important questions about the future direction of research. Will the only questions asked be those for which a sponsor can be found? Will money or intellectual curiosity drive university research? Given the potential dominance of corporate sponsorship who will the university really serve?

Transgenic Pharming

Biopharming is being developed in many places. It is essentially using the genetically modified plants to produce common or new pharmacuetical products. Biopharming promises more plentiful and cheaper supplies of pharmacuetical products and therapeutic proteins for disease treatment (Byrne, 2002; Degregori, 2001; for opinions see—Kohoutek, 2004; Lamb, 2004; Lampman, 2000). The near future holds the promise or the fear of plants engineered to produce vanilla, soybeans that produce palm or coconut oil, which developed nations may no longer have to import. Bananas containing hepatitis B vaccine and Golden Rice with enhanced β carotene (the precursor of Vitamin A) production have been engineered. Plants and animals may be developed to produce specific pharmaceutical products more cheaply than they can be produced in a lab. Transgenic pharming may allow pharmaceutical companies to use plants and animals much like a laboratory. Companies have already produced human hemoglobin in pigs and amino acids humans can not produce in sheep. An enzyme lacking in humans with the genetic disorder Pompe's disease has been produced in rabbits (Middendorf et al. 1998). Is the animal's well-being affected or is it only human need that matters? Ought we to use animals as chemical factories? If we can do it, ought we? Why not? As pointed out by the Economist (October, 2004b) the biggest hurdle for all non-food GM products is not the technology, it is public opinion.

The Precautionary Principle

The essence of the precautionary principle is—if one is not sure what may happen, caution is the proper course of action. In its simplest terms it is—look before you leap (Dundon, 2003). Caution prevents Calvin's (Watterson, 1993) inevitable problem. Dundon (2003) is correct in his assertion that

> it is astonishing to see serious players in agriculture maintaining that one does not have to look before leaping unless one has solid demonstration that a cost effective looking is called for. If someone wishes to impose a risk on me for his benefit, it is his task to demonstrate that the risk is minimally likely to happen. And then the choice is still mine. What part of that is hard to understand?

The precautionary principle has only been applied in environmental policy since the 1970s and is explicitly incorporated in the environmental policies of several countries, but not in U.S. policy (Raffensperger & Barrett, 2002). There are three essential parts: If there is reason to believe that harm may result from an action or a technology and if there is scientific uncertainty about the harm, measures to anticipate and prevent harm are necessary and justified. Harm to humans, other creatures, or the environment all count, but not equally. There is no uniform global policy on application of the principle. It is harm that counts most and it counts more than profit or technological innovation. Openness and transparency are required as is adherence to the democratic principle that the consent of the governed is required when great changes are made. The advocates of agricultural biotechnology claim that sufficient caution is being practiced in all phases of biotechnology development. In fact, many regard the process as over-regulated and at risk because of excessive regulation. Others, of course, see the entire process as under-regulated with insufficient precaution. Only economic potential and future profit matter. People's unreasoned fears and potential, but unlikely, effects on small farms, communities, and the environment will be neglected if profit can be made. These contrasting polar views are real, if a bit exaggerated. If dialogue can be conducted to bring the polar opposites closer together it may lead to resolution of many of the moral dilemmas surrounding agricultural biotechnology.

Eating is a biological necessity, a daily ritual, and a cultural experience. It is something all creatures must do. Come let us break bread together. How could people who must eat not be concerned about what and how they eat and what is being done to their food. Agricultural biotechnology has been and will continue to be a scientific success story. It remains to be seen if it will also be cultural success.

Prometheus gave us fire and we have been burned. Pandora opened her box and the only thing left in it was hope, which we strive for. Eve encouraged Adam to eat the fruit from the forbidden tree. As children we often do exactly what we are told not to do. We are risk takers and that is often how we learn about risks and opportunities. We explore, we risk, we fail, we harm, but always we learn and try not to make the same mistakes again.

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How to Proceed

The choice, after all, is ours to make. If, having endured much, we have at last asserted our "right to know," and if knowing, we have concluded that we are being asked to take senseless and frightening risks, then we should no longer accept the counsel of those who tell us that we must fill our world with poisonous chemicals; we should look about and see what other course is open to us.

R. Carson. 1962. *Silent Spring*
Pp. 277–278

There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy.

Shakespeare, Hamlet, Act 1, Scene 5

When I was a young boy everyone had read, or at least said they had read, J. D. Salinger's novel *The Catcher in the Rye* (1951). Salinger introduces Holden Caulfield, a young man in search of himself, as all young men seem to be. Holden wants to be somebody who engages in some form of service, but he is having trouble, as young boys do, in defining what that service might be.[1] At one point in the story (pp. 224–225), Holden is conversing with his sister, Phoebe, who asks him what he would like to become.

"You know what I'd like to be? I mean if I had my goddam choice?" . . .

Phoebe responds, "What? Stop *swearing*."

"You know that song, 'If a body catch a body comin' through the rye'! I'd like—"

(Phoebe breaks in.) "It's 'If a body *meet* a body coming through the rye'! It's a poem. By Robert Burns."

"I know it's a poem by Robert Burns."

[1] My source of this view of Salinger's story is Birch, B. C. and L. L. Rasmussen. 1978. *The Predicament of the Prosperous*. Philadelphia, PA. The Westminster Press. Pp. 97–98.

Holden regains his composure from this unwanted correction offered by his younger sister and continues.

"I thought it was 'If a body catch a body.'"

. . . "Anyway, I keep picturing all these little kids playing some game in this big field of rye and all. Thousands of little kids, and nobody's around—nobody big, I mean—except me. And I'm standing on the edge of some crazy cliff. What I have to do, I have to catch everybody if they start to go over the cliff—I mean if they're running and they don't look where they're going I have to come out from somewhere and *catch* them. That's all I'd do all day. I'd just be the catcher in the rye and all. I know it's crazy, but that's the only thing I'd really like to be. I know it's crazy."

I suspect many of those engaged in agriculture, whether they are farmers, ranchers, equipment dealers, grain dealers, farm supply dealers, university researchers, etc., see themselves and their profession as having achieved what Holden Caulfield wanted to become. They are the only big ones around and they are quite literally catching the helpless of the world who do not or cannot produce their own food. They are the catchers in the rye, saving those who are about to fall off the cliff of starvation.

HIGHLIGHT 9.1

Some regard using food as a weapon to gain political alliances or punish political opponents as a means justified by the desirable ends it serves. However, a counter-argument to this position is that it is morally unacceptable to mistreat anyone or to cause humans to suffer, especially if they are poor and powerless and can be manipulated by those in power. There cannot be a just war if food is used as a weapon because the weapon cannot be effectively directed. When a country attempts to use food as a weapon it fails. The weapon is directed at those in power but it hits the powerless.

Rich nations of the world and their citizens regularly face the question of whether or not to give food aid to countries in need and, if so, how to give it and how much to give. It is reasonable to claim that an individual cannot do much to change what happens in other, far-away parts of the world. Because so many (but not all) of the hungry are in distant places people can argue that they do not know anyone there and they are not sure if what they are able to give will actually help those in need. Some also worry that what is given may be intentionally misdirected and help the wrong people. Thus, it is reasonable to conclude that what one ought to do, what it is prudent to do, is nothing.

All Americans ought to struggle with the question of food aid. Singer (1996) notes that the "result of everyone doing what he really ought to do

cannot be worse than the result of everyone doing less than he ought to do, although the result of everyone doing what he reasonably believes he ought to do could be." After making this claim, Singer offers a moral challenge:

> If it is in our power to prevent something very bad from happening, without thereby sacrificing anything else morally significant, we ought, morally, to do it.

This only requires us to prevent what is clearly bad. We do not have to work to create something good. And one only has to prevent something bad from happening, if one does not have to sacrifice anything of comparable moral significance. For example, if one is all dressed-up and walking by the lagoon on my campus when suddenly a child cries from the middle of the lagoon, where the water is deep, one must help. Dirtying, perhaps ruining, one's best clothing, simply doesn't matter. One's clothing is not of comparable moral significance. Many people have, but Singer's moral challenge does not require anyone to sacrifice their own life to save another. It is of comparable moral significance.

The principle does not make any distinction between cases where someone is the only person who can prevent something very bad from happening and where several can act. It is true that when someone is in physical trouble and nearby if it is someone with whom we have had personal contact we are more likely to help. But, and this point is crucial, that does not show that we ought to help someone who is near or dear rather than one who is far away and unknown. A needy person who is near does not have any greater claim on our ability to help than one who is far away that we will never meet or know.

Most Americans accept that, in some way, we are our brother's keeper. We may not ever meet the brothers that we are somehow obligated to keep. We may have to figure out how to catch them when they fall.

However, as Phoebe Caulfield and Birch and Rasmussen (1978) point out they too have misread the lines. Burns poem does not say, "if a body catch a body." It says, "If a body meet a body." With a likely 50% increase in world population over the next few decades, hundreds of millions of people who are not fed well now, and poor agricultural practices in many places, the rich and prosperous undeniably have some duty to help the less fortunate. But those engaged in agriculture may not be called to be catchers but to be meeters. If they choose to view themselves as catchers, it is likely that they will view the solution to the problems of hunger as more production so they can "catch" those who may starve. But if they are to be meeters, then it may be more likely that they will look for the root causes of hunger, which include a lack of food but

also include inappropriate and inadequate agricultural technology, inadequate food distribution systems, oppressive political systems, and omnipresent poverty that creates hunger. These problems exist in several nations outside the U.S., but they are also here at home and if they meet them they are likely to encounter their own involvement in creating the problems. All who are engaged in agriculture should meet the problem in all its complexity and difficulty. If we do not then we may be able to catch only a few until we are able to address and answer the hard questions:

- Is more production in developed countries really a solution?
- Are any existing agricultural systems sustainable?
- Are present agricultural systems ecologically responsible?
- Do we, does anyone, know how to successfully transfer appropriate technology?
- Is our foreign aid organized to help those in need?

Living with such hard questions is never comfortable. If we are to meet those in need we will necessarily proceed with the nagging uncertainty that we cannot know for certain that the right course of action is being followed. We will always see through a glass, darkly and will only know the wisdom of our actions later, after we are compelled to begin. It is certain that the glass will be much darker and the future much less certain if we proceed without considering not just what can be done but what ought to be done. That is, we must ask moral questions and secure a firm ethical foundation for action on problems that are clearly defined.

It is common to believe that we Americans have a God-given right to the American dream, in its purest form. Growth will continue and, in fact, it must continue if we are to have the prosperity and continued consumption we have earned and deserve. Many see this attitude as the epitome of American arrogance and misunderstanding of the world. Yet, we continue to charge ahead without a firm ethical foundation and without even taking the time to consider that foundation. We are like Dickens' Mr. McCawber[2] in David Copperfield. We are sure that "something will turn up" to enable us to go on. We will somehow continually expand the horizon of accomplishment in agriculture. We will somehow feed more people a better diet because agriculture's progress, we assume, is limited only by our skill and scientific knowledge. In fact with the advent of biotechnology, many believe that agriculture's horizon is, once again, unlimited. Many of the strongest defenders of modern agriculture and its undeniable achievements and wonderful technology live in what could be characterized as an echo chamber of their own opinions. They grant credence to good science that

[2] "I have known him to come home to supper with a flood of tears, and a declaration that nothing was now left but a jail; and go to bed making a calculation of the expense of putting bow-windows to the house, 'in case anything turned up,' which was his favourite expression." D. Copperfield, Chapter 11.

supports their opinions and ignore all other information or put it in the category of bad science, whereupon it is dismissed.

Agricultural scientists, the larger scientific community, and the general public now recognize a large set of problems that have been created, at least partially, by agriculture: contamination of water, food and feed by pesticides, eroded soil, fertilizer pollution, pesticide harm to people and other living things, atmospheric contamination by ammonia and methane and their relation to ozone depletion, global warming, overuse of non-renewable resources, loss of wildlife habitat, and groundwater mining (Kirschenmann, 2000b; Pretty, 1995). It is not unreasonable to claim that the agricultural community has been late in acknowledging and addressing these problems. Kirschenmann (2000b) citing Baskin (1997) identifies seven agricultural problems not all of which were caused by the practice of agriculture but agriculture is intimately involved in all seven. The problems are described on the following ten pages.

WATER LOGGING AND SALINIZATION

About 1% of the earth's water is all that is available for human consumption and 70% of it is used in agriculture, primarily to irrigate crops that provide nearly 40% of the world's food. Water scarcity is the biggest threat to world food production and a blue agricultural revolution may be as essential as another green revolution (Postel, 1999). We can do nothing to change the amount of water on the planet but we can change its location and quality.

HIGHLIGHT 9.2

Coleridge had it right when, in 1798, he published the first version of the Rime of the Ancient Mariner:

> As idle as a painted ship
> Upon a painted ocean.
> Water, water, everywhere,
> And all the boards did shrink;
> Water, water everywhere,
> nor any drop to drink.

That is a reasonable description of our world. Water is the most common substance on the earth but 97.4% of it exists as seawater. Of the 2.6% that is freshwater, almost 2% is in polar ice and glaciers. All that is available to us in rivers, streams, lakes and in groundwater is about 0.32% of all the water on earth. That is all we have to drink, bathe in, swim in, irrigate crops with, and do all the other things we do with water. It takes about 2 liters per person

per day to keep us hydrated. That is about the volume of 5.6 cans of soda pop. For a life acceptable to most people, in the world's developed countries, each person requires about 22 gallons per day or 7900+ gallons per year. That means the planet's water supply could support a population of 20 to 25 billion people or 4 times the present population.

No matter what we do we cannot affect the total amount of water on earth but we can and do affect its quality. Postel (2000) asserts that because water is essential to the lives of humans and all other creatures every decision made about water is an ethical decision. There is a finite supply of usable water that can support life. We value a continued healthy life but Postel claims that no living creature has a greater right to life than any other living creature. Environmental preservation and sustainability, for all creatures, are dependent on water.

In the US, about 85% of the fresh water used is used in agriculture and most of that (at least 80%) irrigates crops. Most US irrigation is in the 17 Western states, on 12% of the US crop acreage, that produces 27% of the US crop value. Worldwide, about 18% of crop land is irrigated and that land produces about one-third of the world's crops.

The following are some examples of the dimensions of the water problem.

—An estimated 2 million children die each year (6000 each day) from diseases linked to bad water. Most of these children live in Africa and Asia but some live in the US and Europe.

—The world's golf courses use 2.5 billion gallons for irrigation each day. The same amount of water would support 4.7 billion people with the UN daily minimum intake (World Watch March/April 2004, p. 36).

—The wetlands area (150,000 acres) of the Colorado river delta receives about 0.1% of the water that once flowed through it. The same area could be covered to a depth of 2 feet with water drawn from the river by the city of Las Vegas, NV, which uses much of the water to irrigate more than 60 golf courses (World Watch March/April 2004, p. 36).

—The human demand for water has been particularly devastating to wetlands. Globally the world has lost half of its wetlands, most in the last 50 years. One-fifth of the world's fresh water fish are endangered, vulnerable, or extinct (see Greenbiz.com Feb. 5, 2003).

—Wealthy citizens of the world spend US $14 billion on ocean cruises each year. According to the World Watch Institute (State of the World 2004, p. 10) US $10 billion annually could provide clean water to the estimated 1.1 billion people who lack it, in a world that spends about $240 million a day on tobacco products.

—The Glen Canyon dam created Lake Powell, which was designed to hold 24.3 million acre feet of water (one acre foot is about 325,851 gallons). In

1999 the lake was full, forcing water releases. In April 2004, the lake had only 10.2 million acre feet (42% of capacity), a level last seen in 1971. Given the continuing drought in the Western US, experts predict the lake could be dry by 2007. Lake Mead behind Boulder dam is at 59% of capacity. (See *The Denver Post*, April 4, 2004, p. 10A.)

—Half of all the world's hospital beds are occupied by people with water-borne diseases.

—In India only 30% of the population has access to clean water.

—Over-pumping of ground water is causing water tables to decline in important agricultural regions of Asia, North Africa, the Middle East, and the US. The quality of groundwater is also declining. (State of the World—2004. p. 17).

—Annual water withdrawals per person in cubic meters

US	= 1688
Australia	= 945
Germany	= 712
China	= 431
UK	= 201

—India has 2.2% of the world's people, 4% of its fresh water, but 17% of its population.

More than a third of the world's people may soon live in areas that are water stressed. One can only conclude that water will be one of the primary factors that limits future world population growth and economic development. It is right to begin to consider if the proper goal is water for the wealthy nations or fresh water for the two-thirds of the world population that faces daily water stress?

As the worldwide demand for fresh water increases and the supply of good quality water diminishes, water is becoming more a manipulated commodity than a free good and its inequitable distribution has enormous political ramifications. For example, India has 2.2% of the world's arable land, 4% of its fresh water and 17% of its population. It would require 2.5 billion gallons of water to support 4.7 billion people with the UN daily minimum water requirement, which is precisely the amount of water now used to irrigate the world's golf courses (Anonymous, 2004). Water supply and use raise ethical questions and demand ethical responses.

No irrigation dependent society, with the possible exception of Egypt, has survived; all have failed due to water logging or salinization of the soil, or both. "The overriding lesson from history is that most irrigation-based civilizations fail. As we enter the third millennium A.D., the question is: Will ours be any

different" (Postel, 1999, p. 12)? It is accepted that these failures have been caused by poor irrigation practices but salinization and water-logging of soil still occur.

DESERTIFICATION

Baskin (1997) suggests that 70% of the world's drylands are now threatened by desertification and no one knows how to reverse the process once it has begun. Douglass (1984) estimates that desertification is removing at least 50 million productive acres in the world's arid and semi-arid regions. Today the world will lose another 72 square miles to encroaching deserts, an area equal to the size of West Virginia over a year (Orr, 1994, p. 7).

DEPLETION OF WATER RESOURCES

About a third of the world's food is produced on irrigated land. Irrigation is proven technique to increase and assure yield. It has allowed production of high value crops in areas where only low-yield, dryland agriculture was possible. In many of the world's irrigated areas (e.g., the Ogallala reservoir under the high plains of the western United States where withdrawal is three times greater than recharge, India's irrigated areas, China) water is being used at a rate faster than the source is being replenished. Water is being mined with abundant short-term gain leading inevitably to long-term failure.

SOIL EROSION

Under agricultural conditions, it takes about 500 years to create an inch of topsoil, which can be lost in minutes. World agriculture contributes to a soil loss of 24 billion tons each year (Baskin, 1997). In 1982, the USDA (http://www.nrcs.usda.gov/technical/land/meta/m5852.html, accessed February 2005) estimated that 3.1 billion tons of U.S. topsoil were lost annually from wind and sheet and rill erosion on cropland and conservation reserve land. The situation has improved but not enough. The U.S. average for sheet and rill erosion was 2.9 tons/acre/year in 1987, 2.2 in 1992, and 1.9 in 1995 and 1997 (http://www.nrcs.usda.gov/technical/nri/1977/summary_report/table10.html, accessed January 7, 2005). USDA also reported that erosion rates in some areas in the 1970s were above 5 tons per acre (soil's estimated natural renewal rate) on 33% of corn acres, 34% of cotton acres, 39% of sorghum acres, and 44% of soybean acreage. Cropland soil erosion varies from an average of 10 metric tons per hectare in the U.S. to 40 in China, and as high as 5,600 in parts of India (Pimentel & Wilson, 2004). Soil is agriculture's ultimate resource. Modern

agriculture is dependent on maintaining soil as its productive base but is failing to do so. Since widespread farming began in the eighteenth century in the U.S., it is estimated that 30% of all farmland has been abandoned because of soil erosion, salinization, and water logging (Pimentel, 1995). As much as one-third of all U.S. topsoil has been lost and most U.S. land is eroding soil at a rate above the soil regeneration rate (Pimentel, 1995).

POLLUTION

Soil erosion depletes agriculture's ultimate resource and the lost soil pollutes water. Fertilizer in soil leads to eutrophication of rivers, streams and lakes. Between 30 and 80% of applied nitrogen is lost to the environment (Conway & Pretty, 1991). The relationship between fertilizer use, soil erosion, nitrogen runoff and the dead zone in the Gulf of Mexico was mentioned in Chapter 1. Pollution of the environment and specifically water and soil from pesticide use is a well known problem. Harm to non-target species from pesticide use in production agriculture is a major ecological concern. Global pesticide use has increased from almost none prior to 1950 to 4.7 billion tons per year. The 3 million cases of pesticide poisoning in the world each year (WHO, 1990) mean that, on average, 6 people are poisoned by pesticides somewhere in the world each minute. Of those poisoned, 220,000 die annually, mostly in the world's developing countries (WHO, 1990, cited by Pimentel & Greiner, 1997, p. 52).

LOSS OF FARMERS

Although it is proper to think of soil as agriculture's ultimate productive resource, farmers are agriculture's primary knowledge resource. Most people regard farming and ranching as routine, humble, non-intellectual activities that are performed by people (usually, it is assumed, by men) who are fundamentally, poorly educated hicks.

HIGHLIGHT 9.3

Visit www.kansasfreeland.com to learn that if you are willing to move to Plainville, KS you can obtain a building lot—free. Plainville (population just over 2,000) in Rooks County (population 5,800) of northwest Kansas, is offering free 143 by 175 foot lots for the construction of new homes. The North Town Addition project will give people a chance to build a home and live in a small-town atmosphere, and at the same time, have big city conveniences

not far away. In May 2005 four building lots were available on a first-come, first-served basis. Several communities in Kansas are offering free land and other incentives. The goal is to help rural areas remain viable and to promote economic growth.

If Kansas doesn't appeal, think about Chugwater, WY, 2,000 population = 244, with a median annual income of $23,750, an average temperature of 46.7 in January and 69.4 in July. The wind blows most of the time. Beginning in May 2005, Chugwater will grant newcomers a 100 by 120 foot city lot, if the applicant agrees to build a house and live in it for 2 years. If you like peace and quiet, Chugwater may be your place. The town has no policeman, no traffic light and not much traffic, no grocery store, and no bar, but it does have a soda fountain with 48 flavors of milkshakes (see *Denver Post*, April 24, 2005, pp. 1a and 8a).

Rural America is emptying. Almost 700 rural US counties lost more than 10% of their residents between 1980 and 2000. Most, but not all, are in the Central Great Plains. In 1900, 60% of the US population was engaged in some kind of agriculture; today less than 2% is and their number is declining. Fewer than 4% of US farms produce about 56% of all agricultural sales. In Colorado, nearly 6 million acres were "developed" from 1992 to 1997; more than double the conversion rate from 1982 to 1992. There are some exceptions, but in most US states, census data show that, the number of farmers declined from 1940 to 1987 and the size of farms increased. The average age of US principal farm operators was 55.3 years in the 2002 census and has increased in each census since 1978.

Use of these data often elicits an accusation of nostalgia for the good old days. I am guilty. I am nostalgic for what I know I have lost. The challenge then goes on to assert that society does not have any obligation to preserve or to save what someone may love. The corner gas station is gone. The Mom and Pop grocery store has disappeared in most places, and few lament their passing. Are there any rural blacksmiths left? It is progress and one gets in its way at one's peril.

Small farms are economically (they make little, if any, profit) and productively (yields are low) inefficient. Our economic and production system compels small farmers to use technology that they may know is not sustainable and is not compatible with being a good farmer. Survival has a higher value than environmental correctness. Small family farms may no longer be good stewards of the land. Without thinking about it the American public has tacitly agreed with the political decision to let small farms disappear. They, after all, are small, they disappear quietly without political turmoil. Those affected don't demonstrate in city streets, they don't riot or cause riots; they just go away, quietly.

> What we are headed toward is a food system that is supplied by 50,000, or so, large farms and ranches each of which will be efficient and productive. That is what will be gained. What is lost? When we lose farms and ranches where a family owns a majority of the capital resources, makes the important management decisions, and provides most of the labor, have we lost anything else? We have lost a group of people who have a daily, personal contact with nature. People who create, populate, and assure the continuance of rural communities with a social contract that works. These folks are in it for the long haul. They create sustainable human and agricultural systems. Their communities have a tightly knit social fabric that seems to be the antithesis of the alienated urban centers where most Americans live. We have also, in a very real sense, lost our seed stock. Those who teach in land-grant agricultural universities can teach students a lot about farming and ranching but to really learn how to farm or ranch one must walk the land with a farmer or rancher. That knowledge base is disappearing. We always think we know what we are doing and what we are gaining. Dwelling on what we are losing, as we gain is not just foolish nostalgia.

They farm because they chose to or could not make it in a more challenging career. Nothing could be further from the truth. Farmers and ranchers are the custodians and stewards of the world's productive land and they are disappearing rapidly. They are the few who know how to care for the world's most important resource—the land. According to U.S. Dept. of Agriculture data (www.census.gov/population.cen2000, accessed November 2004) the number of farmers has been declining in nearly all U.S. states and average farm size has been increasing for decades. There were 6.5 million farms in the U.S. in 1935 and now there are fewer than 2 million. Of the remaining farms 61% of sales is captured by 163,000 large, industrial farms and most of these are contractually tied with a corporation in a prescribed value chain that obligates them to produce for and sell to the corporation and thus they have ceased to be traditional family farms (Kirschenmann, 2000a) where the farmer owns the land, makes the management decisions, and provides most of the labor. So what? We no longer need a large number of automobile producers to make all the vehicles we need, why do we need all those farmers and ranchers? Consolidation has been beneficial in most manufacturing industries and, it is assumed, it ought to be in agriculture as well. We don't need a lot of small, inefficient producers. We need production and if it can be done best (that is at lowest cost) by a few producers, then it should be, even if that means moving much of our food production outside the U.S. That is the nature of the capitalistic enterprise. Capitalism, a process of creative destruction, has winners and losers. The latter, ideally, are absorbed by the more efficient enterprise. However, as we lose the family

enterprise we risk losing the rural communities that these farms and ranches created and sustained. That loss is also regarded by many as a loss that removes a problem but does not create one. No one, it is claimed, wants to live in rural backwaters that have few of what many assume are the required amenities (convenient places to buy almost anything, fast food, convenient coffee, etc.) of modern life. However, if these places are the source of important American values and if the people who inhabit them take care of the land, we may lose those things as well. Economists understand what cheap food costs but it is much more difficult to place costs on qualitative things: the lives of farm families that are destroyed when the farm is lost, the loss of communities, the loss of heritage. We do not understand these costs because we calculate only what can be quantified. We have not calculated the costs of fundamentally qualitative things. It is worth thinking about.

It is hard to admit, after spending a career professing agriculture in a university, but it is undeniably true, that one cannot learn how to farm or ranch in a university. One can learn a lot about farming or ranching and about techniques and technology. But if one wants to learn how to farm or ranch one must ask a farmer or a rancher. They are the best teachers and they are disappearing. We do not understand what the costs of the loss of their experiential knowledge may be.

POPULATION GROWTH

The world's population is still growing and barring a major disaster (earthquake, nuclear war, massive flooding, worldwide disease epidemic, etc.) it will continue to grow for the next few decades but the growth rate (1.4% per year, World Bank 2002) will continue to decline. One can not blame those who practice agriculture for population growth but agriculture's role is clear. Without production increases, the expected increase in population will not be possible. There will not be enough food. Agriculture's practitioners have always claimed credit for feeding people, therefore they must share at least some of the blame for population growth. Most of the problems enumerated herein were, at least partially, enabled by the practices agriculture's practitioners adopted to increase production. As mentioned previously the human ecological footprint (see Wackernagel & Rees, 1996) has grown partially due to the increased wants of the rich and partially due to the sheer increase in the number of people the planet must support. A major challenge for the agricultural community is to design production systems that produce sufficient, high-quality food without causing further harm to the ecological systems on which production depends. We may find we need farmers and ranchers, lots of them, and we will need to pay them to be stewards of the land and ecological caretakers as well as to be producers.

Many authors agree either with the pessimistic view of Carson (1962) quoted at the beginning of this chapter and the dominantly negative view of agriculture's environmental effects presented herein. For example McNeill (2000, p. 358) says "In any case, human history since the dawn of agriculture is replete with unsustainable societies, some of which vanished but many of which changed their ways and survived. They changed not to sustainability but to some new and different kind of unsustainability." McNeill (2000) suggests that the ecological buffers—available new agricultural land, unused water, unpolluted spaces—that made it possible for societies to make it through difficult times in the past are now gone. Every technological advance in agriculture has brought with it some negative ecological and social effects.

However, other authors argue forcefully that the negative views of agriculture are wrong. Bailey (1995, pp. 1–2) states that the environmental movement that began with Earth Day 1970 has "scored some major successes" but has "been spectacularly wrong" about many things. Global famines predicted in the 1970s (see Paddock & Paddock, 1967) have not happened, all forests have not been cut down, global warming is not as serious a problem as predicted, and far less damage has been caused by pesticides than Carson predicted in 1962. Bailey cites several things that support his optimistic view:

- Global life expectancy more than doubled in the twentieth century.
- Despite a tripling of world population, global health and productivity have exploded.
- The world population growth rate has steadily declined.
- Problems typically associated with overpopulation (hunger, overcrowding, poor living conditions) are more properly identified as problems of poverty.
- Global per capita food availability rose by almost a third from the 1930s to the 1980s.
- Worldwide per capita food availability has kept pace with population growth.
- Where natural resource supplies have dwindled they are more properly related to poor government policies.

Bailey's 1995 book was followed by the much more successful work by the Swedish statistician Lomborg (2001). He argued that all (not just some) of the literature and science of environmental pessimism has been written by dissembling environmentalists whose aim is to panic citizens and legislators into inappropriate action to save a planet that is not in danger. The environment, in Lomborg's view is not bad and getting worse, it is good and getting better. "On practically every count, humankind is now *better* (italics in original) nourished. The Green Revolution has been victorious." Production has tripled in developing countries, calorie intake per capita has increased, and the proportion of starving people in the world has decreased. In short, the negative environmentalists have been totally wrong.

Thus, Bailey and Lomborg see progress wherever they look and discount the fears of the pessimists. Many find their views refreshing.[3] Others argue with good evidence that pessimism is warranted.[4]

Kirschenmann (2000b), and other thoughtful commentators on agriculture, know that we need to dispense with the myth that in agriculture, production is all that matters. It does matter but it is not all that matters. We must acknowledge that agricultural practice has caused real, enduring harm to the environment and to people (e.g., migrant labor and small family farmers who have been driven off the farm). As we dispense with pervasive myths about agriculture, we must also dispense with the scientific myths that pervade agricultural and general science. These myths have been described well by Sarewitz (1996, Chapters 2–6) and were cited by Busch (2000, pp. 66–67).

When science began, the intent of most scientists was to explore and understand nature's complexity. This course was the only one available because scientists had not yet developed the ability to command or dominate the natural world. Perhaps early agricultural scientists and farmers wanted to dominate and subdue nature but they could not. Humans were dependent on and subject to the natural world. Farming often failed due to bad weather, poor fertility, lack of water, or pest outbreaks that could not be controlled. As science developed, efforts were more and more directed toward developing "technologies that could extract economic benefits from nature" (Kirschenmann, 2002). For example, in weed science the emphasis nearly from the beginning has been on ways to kill weeds selectively in crops, and only recently has it partially turned toward developing an understanding of the complex biological systems in which weeds occur and often dominate. Weeds were regarded as inevitable companions of growing crops. They were regarded in the beginning and now as the inevitable outcome of the way of growing crops. They are not seen as problems of the production system that, if modified, might be diminished.

It is a certainty that over time agricultural scientists have developed myths (stories to explain a phenomenon of nature) that guide the conduct of the science. The dominant and commonly accepted myths about science govern not just the science that is done but also its public acceptance, and social consequences. Every scientist brings a conception of science to a problem or a new field. There is no such thing as a scientist with a clean slate (Larson, 2004, p. 165). The accompanying myths are unavoidable. The five dominant scientific myths follow (Busch, 2000; Sarewitz, 1996).

[3] A particularly favorable review appeared in *The Economist*—Sept. 8, 2002, pp. 89–90.

[4] For example, see: Bell, R. C. 2002. Media Sheep. World-Watch. March/April. Pp. 11–13. Rennie, J. 2003. Misleading Math about the Earth. Scientific American.com http://www.sciam.com/print_version.cfm?articleID=000F3D47-C6D2-1CEB. Accessed April 3, 2003.

DOMINANT SCIENTIFIC MYTHS

1. The myth of infinite benefit. This asserts "if more science and technology are necessary for a better quality of life, then the more we spend on research the better our quality of life will be" (Sarewitz, 1996, p. 19). Thus, more science and more technology will always yield more public benefits. The scientific enterprise is seen as separate from society and in a pure utilitarian sense it "exists to provide a constant flow of benefits to all" (Busch, 2000). Sarewitz (1996, p. 19) says many scientists hold that "the more innovation we have, the more competitive we will be as an economic entity, and the healthier we'll be as a nation." Science is to be regarded as, and scientists often think of themselves as, people engaged in an activity that provides the greatest benefit to the greatest number of people. This attitude ignores two things: the benefits of science are usually most readily available to the rich and research very often creates new, unforeseen problems that have to be solved. The benefits are accepted and credit is sought for solving some problems. Unsolved and new agricultural problems are commonly externalized and become social costs.

Kirschenmann (2002) pointed out that this utilitarian science has at least three unintended consequences. The first is that the scientists often misapprehend the true nature of the problem—why weeds exist in crops may be a more important long-term question than how to control them annually? The dominant question for most agricultural scientists has been how to increase production. This resulted in the wide acceptance of the productionist agricultural ethic defined by Thompson (1995, p. 48), which implies that any behavior, and technology, is good as long as it increases productivity. There was only one imperative—to produce as much as possible, regardless of the ecological costs and perhaps even if it is not profitable to the producer (Thompson, 1995). The productionist ethic has become the dominant ethic because those who practice agriculture have always believed that hard work is followed by an accumulation of wealth, which is morally acceptable. High agricultural production is a sign that the producer has been favored by God's grace. Thompson suggests that the ethic has dominated because it is believed that to leave land alone is to squander resources provided by God for our use. We are the designated stewards and producing more is the best sign of our stewardship, because that production benefits all. Secondly, Kirschenmann (2002) suggests utilitarian science has separated us from nature. Utilitarian science believes that nature is to be used by humans but use has led to abuse. Humans believe that they have been selected to have dominion over and to subdue the natural world to provide the greatest good for the greatest number of people. We are not part of nature, it is a place from which we extract benefits; not something to which we belong. While abuse may not be the intent, it is the inevitable result of modern agricultural practice. The experts who conduct agricultural research and those who apply the resultant technology to produce food have not paid much attention to the long-term ecological and

social effects of the enterprise because the immediate utilitarian benefit of production has been so apparent.

The productionist ethic is bankrupt (Kirschenmann, 2004). It is so because it fails to prescribe any standard for agriculture that views nature as anything other than a static, mechanistic structure that can be and ought to be controlled by humans with technology. It assumes nature is stable and largely immune from harm and it assumes that agriculture operates in an economy where value is solely determined by price (Kirschenmann, 2004). Because the evidence is clear that the productionist ethic has led to more harm than good (Green et al., 2004), a new ethic is demanded that guides an agriculture that does not ruin the ecological and social communities on which its success and future are dependent. The history of agriculture is replete with examples of ecological failure in single fields and for entire civilizations (Thompson, 1995, p. 76; McNeill, 2000) but agriculture's practitioners, in their quest for greater production have ignored their own history.

2. The myth of unfettered research. This myth asserts that any scientifically reasonable basic research—the study of fundamental natural processes—will yield social benefits and it ought to be permitted and be publicly funded. Scientists are well-educated people whose specialized training demands they be detached from the concerns of daily life so they can pursue scientific interests that will advance the frontiers of knowledge and improve human life (Busch, 2000). In fact, "researchers motivated by curiosity about nature have produced a great abundance of startling, unexpected and marvelous discoveries over the past fifty years" (Sarewitz, 1996, p. 48). This myth is related to the belief that the scientist, *qua* scientist, engaged in research using the scientific method is and should be unhindered by values. This is patently false. "Political and historical milieus strongly influence the course of basic research" (Sarewitz, 1996, p. 39) in all scientific fields. Agricultural science, like all science, is controlled by the constant, required quest for funding. Legislators and funding agencies have priorities that value some lines of research more than others. Therefore, agricultural research and the scientists who conduct it are not unfettered but tightly bound in a vortex of largely unexamined and unquestioned values.

3. The myth of accountability. This myth claims that peer review of published scientific results and the necessity of repeatability of research results are sufficient to maintain the intellectual integrity and ethical responsibility of scientists. This neat locution which says—trust me, I am a scientist—leaves out the public, which is asked to fund the work but ignore its consequences. If the research meets the criteria of high intellectual integrity and established scientific standards for performance, then society must be satisfied, even if, as has been the case for much agricultural research, it may have undesirable ecological or social consequences.

This myth is explored in Dürrenmatt's (1964) play "The Physicists," in which he asks several relevant questions:

Is it always best to seek to know everything?

Who is to be held accountable for the wrongs science commits, those whose work leads to discoveries that harm ecological and social relationships or those who use the work that others have done to cause the harm?

Can anyone be held accountable for the moral aspects of science?

The play asks the audience to consider, when can one be sure they are doing the right thing, and how does one decide what the right thing is? Dürrenmatt's work raises important questions of accountability for all scientists. It is reasonable to postulate that science is essential to the solution of many of the world's problems. It follows then that it is vital that the public's current high esteem (Sarewitz, 1996, p. 58) for and trust in science must be maintained. The integrity of science does not and cannot end with delivery of a product that is quality controlled and intellectually sound according to science's internal criteria. The scientific honor code, in Sarewitz's view (p. 59) is not just about the conduct of science but must also be about the "ethics and values of science as a component of society."

4. The myth of authoritativeness. This myth asserts that science can provide a rational, objective basis for creating political consensus by separating fact from perception. In fact, the opposite seems to be the case: "political controversy seems uniformly to inflame and deepen scientific controversy" (Sarewitz, 1996, p. 77).

Because, scientists often believe, science is objective and value free (Hollander, 2000), one need only examine the data to know what to do. The falsity of this claim should be immediately obvious. It has been the most contested areas of science that have been the most vigorously debated in the political realm. In agriculture, for example, pesticide use is highly regulated but there is little political or scientific consensus on the effects of pesticides on human health. Animal rights are also prescribed in law but there is still great controversy on animal treatment. Most people are meat eaters but prefer not to know too much about how the animals they eat are treated (e.g., see Schlosser, 2002).

Busch (2000) points out that when scientific consensus emerges, public and political consensus quickly follows. Global warming is a good example of a problem referred to the scientific community by politicians, and, as scientific consensus emerged, international willingness to confront the issues also emerged. But we are all long way from consensus on the use of pesticides in agriculture, confinement rearing of animals, or the value of the productionist paradigm.

5. The myth of the endless frontier. New scientific knowledge generated at the cutting edge of basic science is or ought to be freed from careful consideration of its moral and practical consequences because it will be transformed into new technologies that will be beneficial to the public. Basic science therefore should not be subject to careful scrutiny for its potential consequences because they cannot be known in advance. "Fundamental scientific knowledge is a thing apart, accumulating as if in a reservoir, from which it can later be drawn by applied scientists" (Sarewitz, 1996, p. 98) . . . who create products and processes. It is the consequences of applied science (technology) that should be of concern

and good technological advances are dependent on basic science. Busch (2000) suggests the division is false because basic science and technology are inextricably linked in several ways. This is true because new scientific problems emerge from new technologies and most modern scientific work is dependent on technology developed by science. For example, many university research scientists owe the existence of their position to the early observations that some chemicals could be used to selectively control some agricultural pests and further exploration of pesticidal chemicals is highly dependent on new chemical analytical technology developed to find pesticide residues.

Sarewitz (1996, p. 103) points out that the rise of the environmental movement in the industrialized world marked the end of the myth of the endless frontier. People began to recognize that the conquest of the frontier while it made possible the "liberation from elemental want" and a steadily rising standard of living, carried with it an "acceleration in the exploitation, modification, and despoliation of nature." The moral and practical consequences began to become more important than the material benefits.

PRODUCTION AND ETHICS

In spite of the apparent railing herein against the productionist ethic, production is essential. Production of sufficient, high quality food and fiber is the only viable way to feed the world's people (Rist, 1988). However, one must ask production for what and by whom? Agriculture does not need an ethical foundation that values production over everything else (Kirschenmann, 2004) nor does it need one that abandons the quest for improved production. What is needed is public participation in development of an ethical foundation that allocates agricultural production to assure the primary need of all humans for food is met (Rist, 1988). Agriculture needs an ethic that recognizes the human obligation (a moral claim) to conduct agriculture "in a manner that makes a decent life for humans possible on this planet while, at the same time, retaining the ecological dynamics that sustain life on the planet" (Kirschenmann, 2004). It must be an ethic that is not just human oriented but one that acknowledges the ecological relationships that make farming possible.

To achieve this will require that those involved in agriculture cooperate with all members of the general society. As Chapter 7 noted, creating a sustainable agriculture is not and cannot be just an agricultural responsibility, it is a social responsibility. It is an agricultural task in that those who practice agriculture must change some of their practices. Some changes that should be considered include (Rist, 1988):

1. Reducing losses. Losses during harvest, post-harvest storage, and processing should be reduced. Agriculture could lead the way toward a true recycling

economy, where the waste from one enterprise becomes the feed stock for another.

2. Ending wasteful habits. There are clear, well-reasoned arguments concerning the moral status of animals (e.g., see Cavalieri, 2001; Rollin, 1989, 1992; Singer, 1977, 2002). There are equally clear, well-reasoned arguments that animals are essential to a truly integrated, sustainable agriculture (von Kaufmann & Fitzhugh, 2004; Smil 2000). This debate must be resolved and part of the resolution will be a diminution of the excessive consumption of meat which is harmful to human health and wasteful of resources (e.g., land and grain) that could be used to feed people
3. Ending pollution. Pesticide use, especially prophylactic use, and excessive fertilizer use will have to be diminished. Erosion of soil must decrease to protect our most valuable environmental resource and to diminish water and air pollution.
4. Policy changes. If the public wants farmers to adopt practices that conserve energy, reduce pollution, and promote ecological stability, policies that reward farmers for adopting such practices will have to be adopted. Most farmers know how to farm in ways that prevent soil erosion, do not mine water, reduce pollution, promote animal welfare, and strive for ecological harmony. Present government and market policies that reward only production must be changed so desirable practices are rewarded.

The preceding pages have emphasized some of the harms agriculture has done in its endless quest for more production. Those harms have created agriculture's public image, which is not favorable. Kirschenmann (2000a) proposes that those who practice agriculture must change its public image, essentially because agriculture has lost its connection to the public. Most people in developed countries are not farmers or ranchers and have no connection to the source of their food. People eat but do not know how their food is produced. Kirschenmann (2000a) said it well:

> If agriculture is purely an industrial act whose only purpose is to manipulate the technologies required to produce some wheat *with which we have no connection*, that is ground into flour in some distant factory *with which we have no connection*, made into frozen bread dough in some warehouse-like bakery *with which we have no connection*, and placed in to a microwaveable plastic container *with which we have no connection*—and all the while the process may be harming monarch butterflies, or rendering our water unfit to drink, or killing off the fish in our favorite streams—*how could we expect the public to support agriculture?*

THE IMPERATIVE OF RESPONSIBILITY

To create a new public image, those who practice agriculture, those who study it, and all who benefit from it because they eat should consider adopting, as a

general standard, what Jonas (1984) calls an ethic of responsibility. The responsibility is to the future, a philosophically debatable proposition because no one knows what the future holds. We cannot know the people who will inhabit the distant future (50 to 100 years hence), what their situation will be, or the kind of world they will inhabit, therefore, we cannot assume we are obligated to them. We cannot "catch" them and won't ever "meet" most of them because we won't inhabit the distant future.

HIGHLIGHT 9.4

According to the World Bank almost one-half of the 6.4 billion people on earth live on less than US $2 per day and more than 1 billion live on less than US $1 per day. "Some of this misery is caused by incompetent and rapacious governments in the developing world, but not all of it. For more than two decades, dozens of impoverished countries have been forced to spend more money servicing loans outstanding to wealthy foreigners than on hospitals and schools. In many cases, the governments that took out these loans no longer exist, but their successors are shackled by onerous interest payments." (Cassidy, 2000)

Jonas strongly suggests that even though these things are true, we ought to accept an obligation to the future. He suggests present humans do not want to consider that the happiness of future generations of humans should be bought with the unhappiness or even partial extinction of present humans. Given this disposition of present humans, it is not logically inconsistent, in Jonas' view, to posit that the price of the happiness and well-being of present humans should not be bought at the cost of the existence or happiness of future generations. The difference in the two cases is that in the first case future humans are assured, albeit, perhaps, in diminished circumstances, while in the second case, future humans may be eliminated. Sacrifice of the future for the present is logically in Jonas' view "no more open to attack than the sacrifice of the present for the future." The imperative thus becomes—"Act so that the effects of your action are compatible with the permanence of genuine human life." Or, in a negative expression, "Act so the effects of your action are not destructive to the future possibility of such life." In Jonas' view, we are obligated to try, to the best of our ability, to create "the conditions for an indefinite continuation of humanity on earth." Why? Because anyone may choose to risk or end one's own life but no one has the right "to choose or even risk, nonexistence for future generations on account of a better life for the present one" (Jonas, 1984). It is a reasonable argument and a compelling moral claim.

When one attempts to apply the imperative of responsibility to agriculture, the essential human activity, it is clear that the obligation is a collective not

just a personal one. Agriculture is a private enterprise with large public consequences and therefore, the public must act to help create the kind of agriculture that assures "the indefinite continuation of humanity on earth." To illustrate the point that the achievement of a sustainable agriculture is not just an agricultural responsibility one need only look at some trends in U.S. agriculture (http://www.usda.gov/nass/pubs/trends/farmpopulation.htm. accessed Feb. 2004). From 1900 to 2000, average farm size more than tripled, the number of farms has declined by about one-third, while the number of acres farmed remained about the same. The percent of the U.S. work force in agriculture declined from almost 40% of the population in 1900 to less than 1% in 1990. U.S. population steadily increased as farm population steadily declined as did the percent of the population living on farms. Total farm output declined slightly as required inputs and productivity per worker increased dramatically. The market value of agricultural production became concentrated on fewer farms because of the combined effects of the increased capital requirements in farming, higher levels of costly mechanization, and higher government price supports. Farming and ranching became more efficient in terms of production per worker, more costly, and less profitable for farmers. Improved technology increased production and created the many environmental and social problems that have been mentioned. The ethics of agriculture and the ethical dimension of its many problems have not been of concern as long as production increased. The USDA web site, cited above, claims that there is a recognition among the U.S. citizenry that "families involved in farming and the diversity of farm operators are important to the cultural identity of our country. The farming and ranching lifestyle is still believed to be an important and virtuous endeavor, worthy of continued support." The statistical evidence does not lead to the conclusion that those engaged in this virtuous endeavor have received much support to continue or even to survive in agriculture.

Many will argue that the trends in agriculture are to be expected. They simply follow the trends of consolidation and promotion of production efficiency in all important industries. If the U.S. can be fed by ten (or some small number) highly efficient, well managed farms and ranches, that will be good for all. The argument is a clear economic one and is persuasive. It is not a moral argument and as Busch (2000) says, "ultimately moral suasion is more effective for most adults than incentives." But agriculture has not engaged in moral suasion. Those engaged in agriculture have ignored moral arguments because they have thought they had already won the moral case by feeding people, a morally acceptable act, and ignoring the harms done. No one in agriculture has tried to learn if the public really wants more production if the environmental and social costs remain high. The Green Revolution helped to feed the poor especially in Asia but not in Africa because the successful high-yield crops (wheat and rice) are less widely planted in Africa. The clear environmental and social costs (massive, often inappropriate, pesticide use, loss of genetic diversity, disruption of stable rural cultures, development of a system that favored large farms, small farmers being

driven from the land, and development of genetic crop monocultures with increased disease and insect susceptibility) have been high and largely ignored by agricultural scientists and agribusiness people. These costs have been regarded as the price of bounty. Such unexamined, yet certain, moral positions are potentially dangerous to agriculture because if they persist the argument about agriculture's future may be lost without being engaged.

There is competition and conflict within agricultural science for research funds and attention from the media. There is no concern about agriculture's moral status because it is not debated. Agricultural science, similar to other science, has its scientific facts in order although its underlying theories, which determine what facts are acceptable, may be less certain (Barker & Peters, 1993). Agricultural science suffers in its quest for funding and in its public image because there is not one scientific reality but several, which is as it should be (Barker & Peters, 1993). Scientific advice on public policy issues should, at its best, be conflicting because the social and physical worlds are so. Science in agriculture, or in any other discipline, cannot and should not attempt to give the final definitive answer on what ought to be done in public policy. The task is to interpret scientific findings with all their uncertainty but not to provide the definitive answer to complex social and environmental questions. However, those who give advice will be able to be surer of their answers and advice when they rest on a firm, well-articulated ethical foundation. A firm ethic is a moral theory in which considered intuitions have been brought into equilibrium with moral principles and scientific knowledge (facts) (Comstock, 1995). If science promotes its technology as it has in the past in the absence of moral scrutiny the results are likely to be technologically successful as they have been in the past but the social and ecological effects may discredit rather than honor the scientific developments and the entire scientific enterprise (Wright, 1990, p. 236).

Wildavsky (1995, pp. 439–441) is correct in his assertion that many of the public's fears about the harm caused by agricultural science have a moral foundation. The fears explain people's risk perception and may determine government policy, but they are out of place in determining risk consequences. A fear based on a perceived moral wrong (e.g., it is morally wrong to use pesticides that harm humans, non-target species, or the environment) and the perception of harm, is not the same as the presence of harm. Wildavsky (1995) advocates "citizenship in science" as a prerequisite to moral outrage and demands to stop an action or "to get rid of the stuff," regardless of the cost. What is wrong in Wildavsky's (1995) view is that moral outrage has been allowed to lead policy in spite of clear scientific evidence, which although the moral outrage is clear, does not support the claim that harm to anything has been caused or is likely to result from continuation of the practice. Those who practice agriculture, those who do agricultural science, and those who raise moral issues and complaints must all be responsible morally and scientifically.

FINDING PARTNERS

As those engaged in agriculture expand the realm of enquiry about agriculture they may find it interesting to know who is asking the same questions and with whom it may be good to form partnerships to raise and discuss agriculture's ethical issues. Zimdahl and Speer's (1998)[5] paper examined mission statements of agricultural producer groups and asked if they shared missions and objectives with environmental groups and agribusiness companies. They asked which of these three groups will be the best sources of intellectual and moral support as land-grant universities strive to fulfill their respective missions.

When discussing interpretation of scientific results with students and colleagues, a common approach is to examine the data. Show me the data is a prominent research theme and pedagogic technique. What the data reveal when expressed quantitatively in tables or figures helps guide us toward the meaning of an experiment and its conclusions. Scientists prize and try to teach students to prize conciseness. When they express a large truth with simplicity and brevity, this approaches scientific truth and perhaps beauty (Krauthammer, 1997). Scientists believe in the wisdom of Occam's razor: When confronted with two or more explanations for a phenomenon, the simpler, less complicated one is most likely to be correct. Therefore, scientists strive to find simple explanations that are supported by the data.

Scientists are continually challenged and frustrated by questions about science that are not based on the data. These often come from colleagues in non-scientific fields and from the general public. They are questions that can not be answered by the data or by attempts at elegant simplicity, because they originate outside the established bounds of scientific procedure. The questions are not about what the data mean, but rather about what one intended to do because of the data, or about why such work was done at all. They probe the process and goals of science, but they are not empirical, narrow scientific questions that can be answered by appeals to the data. Ultimately, they are questions about the nature of the mission of agricultural science and the techniques used to accomplish the mission.

The purpose of Zimdahl and Speer's (1998) paper is to examine divergent views of agriculture and its mission. Publicly available mission statements or statements of objectives[6] from three groups that participate in agriculture are used. Mission statements of 16 agricultural businesses (agribusiness, Table 9.3), 22 agricultural producer and allied groups (producers, Table 9.4), and 25 environmental groups (environmental, Table 9.5) were examined. The division was created

[5] Much of the following is reproduced with permission from Zimdahl, R. L. and R. L. Speer. 1998. Agriculture's Mission: Finding a Partner. *American J. Alt. Agric. 16*:35–46.

[6] All mission statements and statements of objectives were obtained from printed material sent to RLZ in 1998 and 1999 or from the internet in 1999.

because while each group is involved in agriculture, it was assumed that the nature of the involvement would create differing views of agriculture's mission. There was no attempt to pick all possible representatives of each group. The first hypothesis was that agricultural producer groups share missions and objectives with environmental groups, and their mission statements should demonstrate their shared goals. These groups usually see each other not as allies but as adversaries. A second hypothesis is that agricultural producer groups do not share missions or operational objectives with agribusiness companies, and their mission statements should demonstrate their lack of common interests. The members of these two groups usually regard each other as allies because the latter provides the technology that enables the former group to produce. Based on publicly available mission statements, Zimdahl and Speer (1998) discuss whether the agricultural producer group's best partners are agribusiness companies as assumed, or whether agricultural producers and environmental groups share missions and resulting activities. A major limitation of examining mission statements is the confounding of statements because members of each group intentionally use words and phrases that they believe will be acceptable to the public.

MISSION STATEMENTS

Members of each of the three groups frequently proclaim that promotion of the public good is their highest goal, and that appears to be an important standard by which they wish to be judged. Agricultural producer and allied groups contribute to the public good by producing food, feed, or fiber (e.g., National Corn Growers Association, National Cattlemen's Beef Association, Table 9.4) or by aiding production (e.g., American Soybean Council, Farm Bureau, Table 9.4) of abundant, high-quality food, feed, or fiber. Agribusiness does this by creating the technology for high yields and adding value to farm products (e.g., Archer Daniels Midland Company, Dow AgroSciences, Table 9.3). Environmental groups serve the public by working to protect and preserve the environment (e.g., National Audubon Society, Sierra Club, Table 9.5). Some mission statements suggest that members of each group agree that environmental integrity is the *sine qua non* for life on the planet.

Although mission statements do not reveal this, it was assumed, with great confidence, that some members of each group recognize the value of good science as a basis for agricultural policy and practice. Many scientists argue that science is the primary tool needed to determine what policy and practice should be. A great deal of agricultural research is done in agribusiness companies; much of it is proprietary, which means that neither the process nor the results are published in open, peer-reviewed scientific journals, and therefore they are unavailable for use in determining agricultural policy and practice. The results are confidential and used to further the company's interests, rather than to build the

corpus of general scientific knowledge or to serve as a basis for public decision-making. This is not *a priori* ethically objectionable; it is good business practice. The frequently closed scientific community of agribusiness does not have great concern about the importance of public participation and evaluation. This acknowledged good business practice may not be ethically objectionable, but there is a rising belief in the United States that companies owe stakeholders (whose number is larger than the number of stockholders and includes customers, employees, activist groups, agricultural producers, and other citizens) an accurate, complete reporting of their scientific activities, including both positive and negative findings (Grose, 1999).

Another setting for agricultural research in the U.S. is within state- and federally-supported land-grant universities, whose mission statements were not part of the study. These institutions have been designated by their respective state legislatures or by the U.S. Congress to receive funds allocated by the Morrill Acts of 1862 and 1890. There are 105 land-grant universities (Rahm, 1997), at least one in each U.S. state or territory. The number includes 29 Native American Tribal Colleges established in 1994. Not all land-grant schools have a college of agriculture (e.g., The Massachusetts Institute of Technology).

The land-grant universities are supported, in part, by state and federal tax dollars. In the democratic tradition, it follows that those who are affected by the consequences of any activity and those who pay have a right to a voice in decisions about how activities supported by their tax dollars may affect them (Sclove, 1998). In short, because of the nature of these institutions, in contrast to agribusiness companies, there is an obligation to be open and public about scientific research and its meaning. Further, it should not be assumed that scientists, professors, and administrators of science programs in universities have a monopoly on expertise, nor that they have any claim to a privileged ethical view from which to evaluate the declared scientific, social, or environmental missions that affect scientific research, science policy, or the uses of scientific research (Sclove 1998). Based on their published mission statements, 6 environmental (of 25 total) and 4 agricultural producer groups (of 22) surveyed share views about the importance of public participation and evaluation (Table 9.1).

Zimdahl and Speer (1998) suggested that agribusiness groups assume that new agricultural technology and current agricultural practices inevitably support the public good by increasing production of abundant, high-quality food, feed, and fiber. Environmentally based objections to this view derive primarily from disagreement about the technology required or advocated to accomplish the goal of feeding the world's growing population, and secondarily, disagreement on the perceived imperative for increased production to feed a growing world population more high-quality food. Environmental groups often suggest that insider-only approaches to science policy and practice are antithetical to the open, vigorous, and creative public debate on which democracy and good science thrive (Sclove, 1998), but the mission statements of only 6 of the 25 groups surveyed

TABLE 9.1 Excerpts from mission statements that speak to participation in and evaluation of agricultural research. Full statements are shown in Tables 9.4 and 9.5.

Agricultural Producer and Allied Groups—from Table 9.4	
Council for Agricultural Science Science and Technology (CAST)	To identify food and fiber, environmental, and other agricultural issues . . . for use in public policy decision making.
National Council of Farmer Cooperatives	To protect the public policy environment.
National Farmers Union	To protect and enhance the quality of life of farmers and ranchers and rural communities.
National Grange	To improve the quality of life in America's communities.
Environmental Groups—from Table 9.5	
Californians for Pesticide Reform	To expand the public's right to know.
Center for Rural Affairs	To build communities that stand for social justice.
Consortium for Sustainable Agriculture Research and Education	To cultivate our collaborative capacities.
Food Research and Action Center	To improve public policies.
LOKA Institute	To make science and technology more responsive to social and environmental concerns by expanding opportunities for grassroots public-interest group, everyday citizen, and worker involvement.
Worldwatch Institute	To raise public awareness.

include a statement about public participation (Table 9.5). Environmental groups argue (Smith, 1997) that in modern, capitalist societies there is a tendency for any technology with commercial potential "to further social inequality, undermine popular sovereignty, generate environmental crises, and colonize every nook and cranny of everyday life with corporate propaganda." A good current agricultural example of this phenomenon is the rise and ubiquity of herbicide-resistant crops. A large percentage of the U.S. corn and soybean crop is now planted with seeds genetically modified to be resistant to a herbicide. Questions about the effect of this technology on small farmers and rural communities are asked but largely ignored in the rush to adopt the technology. The resistance to purchasing genetically modified products in many European countries has been recognized by involved agribusinesses (see Chapter 8). The concern was initially dismissed, to be overcome through education by company marketing and advertising groups. This tactic, regarded as corporate propaganda, was dismissed by the public. Environmental problems (some anticipated and others unknown) will likely follow large-scale planting of herbicide-resistant crops. This example seems

TABLE 9.2 Word frequency analysis of Tables 9.3, 9.4, and 9.5

	Word frequency		
Word	Agribusiness Table 9.3	Agriculture Table 9.4	Environmental Table 9.5
Human oriented			
Health, well being, safety, nutrition, nurture	6	10	8
Public, society	0	3	8
Quality of life	1	3	0
Food production	6	1	1
Community	2	3	1
Total	15	20	18
Environmental			
Environment	3	2	9
Sustainable, conserve, restore, preserve	1	0	7
Organic production	0	0	3
Stewardship	0	1	2
Protect nature, preserve respect, biodiversity	2	0	4
Total	6	3	25
Business			
Profit, value, growth	10	4	1
Economic well-being	1	3	0
Technology	3	0	0
Ethical standards	2	0	0
Total	16	7	1

to be antithetical to achievement of some of the human-oriented goals (Table 9.2) that agricultural producer and environmental groups share, as well as to the agribusiness goal of improving business profitability.

Many members of each of the three groups, and especially many scientists, claim that science is value-free. But, as mentioned, science has never been value-free. The logic, practice, and results of science are modulated by social and ethical concerns (Rollin, 1996). Rollin (1996) provides examples of the influence of ethics on science, and similar agricultural examples are plentiful. Within agriculture the massive support (public and agribusiness) provided for pesticide research vs. the comparatively minimal support for organic or alternative agriculture demonstrates the social determination of the subjects that agricultural science investigates. Similarly, there have been few publicly supported investigations of the effects of modern agricultural technology on the survival of small farms and

farming communities. (For an analysis, see Goldschmidt, 1998.) Secondly, Rollin (1996) suggests that social control of scientific methods is demonstrated by the fact that biomedical research is done on rats, who as subjects have no choice, rather than mentally deficient children. At present, pain felt by the rats must be controlled, yet it was not too long ago in biomedical or pesticide research that pain in test animals was not even considered. Most humans recoil at the suggestion that mentally deficient children, who surely would be more appropriate subjects to determine human effects, could be used to test the potential for human harm from agricultural pesticides. It is beyond the pale to even consider such thoughts, and our social ethic tells us so. Finally, the degree of statistical reliability demanded when a new pesticide is being evaluated, vs. testing a new survey instrument to determine social opinion, shows the influence of our social ethic. Statistical estimates of performance and safety are demanded and accepted when an agrichemical manufacturer proposes new pesticide chemistry or a new use for an old pesticide to the U.S. Environmental Protection Agency (EPA) or to a state regulatory agency. On the other hand, when one proposes a new ethical standard, statistical probability is not even considered. For example, who would accept the statement: It is likely that in 5% of the cases (95% probability) the public will reject the ethical justification for preservation of family farms. Such an ethical claim accompanied by a probability statement is virtually unknown. Science, as suggested above, is regarded as value-free and statistical probability is appropriate. Ethical matters, on the other hand, are value-laden and there is no clear standard of proof because we tell ourselves it is all just a matter of opinion. In science one can prove within acceptable statistical limits what the facts are. Science, we often think, reveals the truth, unencumbered by value considerations. Ethics, it is thought, can not reveal the truth because there is no ultimate truth in matters that rest on opinion rather than fact.

Agribusiness does many things superbly, but its marvelous successes in bringing new products to market, satisfying consumer needs (and wants), and creating wealth should not lull us into believing that the ethics of agribusiness (or any other kind of business) are equally applicable to all realms of life. The market, the *sine qua non* of modern business, deserves a place, and democratic institutions are required to provide a check that keeps it in its place (Kuttner, 1997; Okun, 1975). Unfettered markets are regarded as "the essence of human liberty and the most expedient route to prosperity" (Kuttner, 1997, p. 3). However everything must not be for sale (Kuttner, 1997, p. 363); the value of business, even in a capitalistic society, is only instrumental, it has no intrinsic worth. According to George Soros, an extraordinarily successful capitalist entrepreneur, "economic theory is an axiomatic system: as long as the basic assumptions hold, the conclusions follow" (Soros, 1997). The mission statements in Table 1 do not reveal that a fundamental mission of agribusiness in a capitalistic system includes consideration of the moral necessity for humane qualities (love, truthfulness, responsibility) or environmentally beneficial behavior. The more intensely competitive

the commercial environment becomes and the more it reflects economic theory and market principles, the less likely that any corporation will behave humanely or emphasize care for the environment. The agribusiness mission statements (Tables 9.3 and 9.2) mention, but do not emphasize, the environment; likewise, the mission statements of agricultural producer groups fail to include words that emphasize environmental quality. All three groups use words that are human-oriented, but the emphasis is subtly different (Table 9.2). There is more emphasis on food production and safety by agribusiness, whereas members of the other two groups emphasize health, public participation, and human well-being.

THE ROLE OF THE UNIVERSITY

Universities in general, and those with colleges of agriculture in particular, frequently see themselves trapped between the competing demands of the three groups: agribusiness, agricultural producer, and environmental. Well-funded agribusiness is eager to benefit from the intellectual and technological resources of the university to fulfill its research and technology development needs. Most agricultural producer and allied groups regard the university, especially the Cooperative Extension Service of land-grant universities, as an unbiased source of technological and production information about what agribusiness offers. They also fund research, but not at the level agribusiness does. Environmental groups are not notable sources of research funding, but they act as a public conscience and are frequent critics of university-based research. With declining public funding, universities must find other sources to support research and graduate programs, and agribusiness is an obvious and willing source. Those able to attract such support find acclaim within the university. When funding is sought and accepted, intellectual leadership may pass from the university scientist to the funding source. Thus, the scientists of land-grant universities that were conceived and designed to serve agricultural producers find themselves compelled to accept funds and leadership from agribusinesses, whose interests in sales and market share may run counter to the best interests of producers.

The university also finds itself succumbing to demands for service to its "customers," who were formerly called students. Now instead of only the student cafeteria, we find McDonald's or Carl's Jr. in the student center near the flower store, beauty parlor, and branch bank and its ATM machines. Each is regarded as a gain without much thought about what has been lost. We risk losing the university as the locus of intellectual culture which exceeds the sum of its mechanically acquired parts (Readings, 1996, pp. 74–75). We risk losing the essence of one of our oldest institutions, the university, as a place where thinking is a shared process; this is where one thinks and learns how to think. One could argue that McDonald's and ATMs make allocation of time and money more efficient. Once efficiency is invoked other arguments about what may have been lost fade

quickly. It is said that efficiency is one of the things the university must increase or intensify in its quest to be excellent. Readings (1996, p. 119) tells us that the omnipresence of the criterion of excellence in modern universities merely "brackets the question of value in favor of measurement and replaces questions of accountability or responsibility with accounting solutions."

The university is confronted with instrumental decision-making within an imposed system that ignores the needs and values we live by and want to live by (Readings, 1996, p. 94), so that the institution can become as efficient as business. The bottom line of the university is not and should not be measured in dollars or technological advances, but rather in ideas and intellectual creativity (Mac Lane, 1996). Close university/agribusiness partnerships are neither antithetical to ideas and intellectual creativity nor inevitably against the university's best interest and incompatible with the public good. However, if the liaison becomes too close or if the university becomes too dependent on agribusiness, the central locus of investigation may shift from ideas and intellectual creativity toward the university becoming one site among many where attempts are made to hold judgment open as a question (Readings, 1996, p. 120).

Although not unanimous, environmental groups in general support Smith's (1997) strong accusation that "The university is in danger of becoming like the muscle-bound freak with tremendously developed biceps who has let the rest of his mind and body atrophy. Corporate funds are the steroids." Corporate funds could also be regarded as the narcotics that lull their recipients into the belief that pursuit of corporate interests (i.e., commercializable technologies) will achieve the greatest good for the greatest number. Such pursuits, it is argued, maximize public good, a stated goal of some agribusinesses. These are not comfortable accusations to make. They neither achieve the reader's acceptance of the premise, that agricultural producer's best friends are to be found among environmental groups, nor build consensus for future action. As a strategy to build consensus, Daly (1996) reminds us that "it is probably good to keep the most controversial issues for last, even if they are ultimately the most important. But it would be quite dishonest not to bring them up at all."

A related and equally controversial issue is the nature of the university's primary task, which is to take the long view (Mac Lane, 1996). It is important to maintain the essence of the place where one thinks and learns how to think. This view does not emphasize satisfying the wants of the customer of the moment, but rather the legitimate needs of society for years ahead. Universities have existed longer than any modern industrial corporation. They are one of the best ways societies have devised to accomplish the difficult task of discovering and evaluating ideas and transmitting them to new generations (Mac Lane, 1996). The process is slow and unpredictable and does not fit the corporate competitive model (Mac Lane, 1996) which is often the apparent standard for judgment in the modern university: How big one's grant is seems more important than how big one's ideas are. If the long view is the correct view of the university's

mission and therefore of the mission of a college of agriculture, one must ask if that view is most compatible with the stated missions of agribusiness, producer, or environmental groups. Which of these groups will be the best sources of intellectual and other forms of aid to the university as the university strives to fulfill its mission of discovery, evaluation, and transmission of ideas through teaching, scholarship, and service? Similarly, are the goals of either agribusiness or environmental groups more compatible with the goals of agricultural producers, and how do these groups support producers?

Orr (1994) in his discussion of the problem of education begins by citing a bit from an unpublished paper by Elie Wiesel[7] who noted that the designers of the Holocaust were the heirs of Kant and Goethe and were widely believed to be the best educated people on earth. Wiesel described what was wrong with their excellent education:

> It emphasized theories instead of values, concepts rather than human beings, abstraction rather than consciousness, answers instead of questions, ideology and efficiency rather than conscience.

Orr (1994) argues that the same can be said of modern environmental (and by implication) agricultural education: it emphasizes theory, concepts, abstraction, answers (the right ones) and efficiency. There are neat answers to all questions and technical efficiency is paramount. Orr argues that education, even a lot of it, is no guarantee of "decency, prudence or wisdom." He does not advocate ignorance but a different kind of education that emphasizes the standards of decency and human survival. Sir Francis Bacon, the founder of modern science, told us that with increasing knowledge we would gain power over nature (Busch, 2000). Orr (1994, p. 8) says that we gain insight into what is wrong with modern education and our culture from the characters we know or ought to know well. Each of these characters shows the madness of the drive to dominate nature that typifies modern agriculture. Marlowe's Faust trades his soul for knowledge and power, Shelley's Dr. Frankenstein refuses to take responsibility for the monster he created (an externality), and Melville's Captain Ahab said "all my means are sane, my motive and my object are mad."

Our modern educational system teaches us that all problems are solvable and even ignorance, which may be part of the human condition, is correctable (Orr, 1994). I recall learning as a student that metaphorically speaking science was able to shine light on human problems and solve them. I learned that as the area of light expanded it indicated that we knew more and more problems were solved. However, we also learned that as the area of light grew, the area of darkness surrounding it grew more. It seemed incongruous, but as our knowledge grew, our ignorance grew even more. But, that is how the world works. We learn through education what we don't know.

[7] Wiesel, E 1990. Unpublished remarks before the Global Forum held in Moscow.

Orr also suggests we suffer from the dangerous and false myths that as human knowledge and technology increase we will know better how to manage the earth, human goodness will increase, and we will repair or restore that which has been damaged through human ignorance. The data, in each case, deny that these things have happened. Increased agricultural knowledge has led to increased dominance of the natural world, more human misery, and almost no repair of damage. Our cleverness has increased but wisdom has not. Agricultural education cannot ignore the necessity of facts. Students must know about the laws of probability, plant and animal physiology, chemistry, etc. However, agricultural education must also teach students not just what to do but why some things should be done and others ignored. Students must somehow learn about the fact of and how to deal with what James (2003) identifies as Type I and Type II ethical problems (see Chapter 4). Type I problems are important because of difficulty in deciding what ethical norm should apply. Type II dilemmas, common in agriculture, occur when there is a general social consensus on what ought to be done but there is significant incentive to violate the societal consensus. Presently such things are not an integral part of agricultural education, which has an excess of how to and a paucity of why to. Students arrive with a set of personal and social ethical standards. They will likely learn some professional ethical standards while they are in the university. It is not as likely that they will leave with a greatly different set of personal or social ethics than those they had when they arrived. It is highly likely that they will leave the university without a firm moral foundation that will guide them as they engage in the practice of agriculture. In that sense their professors have failed.

SUSTAINABILITY AS A GOAL

Bandwagons come and go (Simmonds, 1991); some pass quickly while others endure and the words associated with them become part of the lexicon. Sustainability may be a bandwagon term. It is too early to tell. Because of its current popularity in agriculture one might expect it to appear frequently in mission statements, yet it does not (Table 9.2). The word is common in agricultural publications and in academic discourse. As discussed in Chapter 7, there is no good definition; the word means what the one using it wants it to mean.

HIGHLIGHT 9.5

In 1997, I was invited to spend two months as a Visiting Professor in the Institute of Plant Production and Agroecology in the Tropics and Subtropics of the University of Hohenheim, Stuttgart, Germany. My host, Professor Dr.

Werner Koch, enjoyed walks in the countryside and invited me to accompany him. On one occasion as we walked over a slight rise I was most impressed with the agricultural vista ahead. There were many small fields, some bare soil, some green with a winter crop or hay, and some with stubble from the last crop. The large area was laced with cement paths on which people were strolling, jogging, biking, pushing children in strollers, or roller-blading. There were no obvious farm buildings. I commented to Prof. Koch that it was nice of the government to pave all the paths so the public could enjoy the countryside. Prof. Koch kindly and firmly informed me that the paths were built by the Government, but not for the uses I observed. They were built so the farmers, who lived in nearby villages, could get equipment to their fields. He then went on to explain what he called the German Landscaping Program (a translation of the German). A major purpose of the program was to keep small farmers in farming. The Government offered farmers the option of accepting some or all of the following conditions for 5 years: no herbicide or growth regulator use, the inter-row distance in cereals was greater than 17 cm, a cover crop would be kept on the land between crops, 20% less fertilizer than normal would be used, and the land would not be plowed. When a farmer agreed to abide by one or all of these conditions, the Government offered a subsidy of points per hectare, which were converted to a payment of Deutschmarks at the end of the cropping season. Each of the stated conditions lowered yield.

Germany is a rich country and does not need all of its farmers to produce more food. Public policy did not favor increasing production but did favor keeping farmers in business. Farmers were valued because they maintained the land and they maintained villages, the center of valued German culture. Maintaining farmers, Professor Koch, assured me, also meant that Germany would look well when tourists visited, a lesser but important goal of the program.

Presently (2005), the German state of Baden-Württemberg has a similar program Marktentlastungs und Kulturlandschaftsausgleich (MEKA), which roughly translates to a program to reduce production while preserving and improving the quality of the cultivated area. The program includes:

- Regular soil analyses to assure appropriate fertilizer use.
- Preservation of vineyards on steep slopes to prevent soil erosion. Old supporting walls are maintained.
- Preservation of land races of economically useful animals (esp. cattle).
- No use of pesticides, fertilizers and growth regulators.
- Reduction of use of nitrogen fertilizer on arable land by 20%.

Inevitable decreases in crop yield are compensated by Government subsidies to maintain farmer's income. The program is used most by small farms. Other

German states and European Countries have similar programs tailored to their area and specific needs. Each program is part of the agriculture-environment initiative of the European Union and is financed by the EU.

The programs accomplish four desirable agricultural goals (see Lehman, 1995, Chap. 10). Safe food is produced, resources are conserved, and the practices are environmentally benign or friendly. Profit is assured by Government subsidies. The programs achieve desirable elements of agricultural sustainability, including protecting producers but they are not sustainable economically, without public subsidy. American agricultural subsidies, it is worth noting totaled more than $300 billion between 1978 and 2002 while small farmers disappeared and the environment was not favored.

A simple definition of sustainable agriculture is, "Farmers should farm so they can farm again" (Wojcik, 1989). Harwood (1988, p. 4) suggested the following definition: "[An] agriculture that can evolve indefinitely toward greater human utility, greater efficiency of resource use, and a balance with the environment that is favorable both to humans and to most other species." There are many other definitions and each is value-laden with words such as human utility, efficiency, balance, and favorable. Most definitions are of Western, developed-country origin and overlook the fact that a sustainable agriculture in a developing country may be that which increases food production to sustain a growing population (Gressel & Rotteveel, 2000). Most definitions derive from an egocentric ethic of management in which the land is an instrument to achieve human ends. They are not based on an ecocentric ethic in which the land has inherent value (Merchant, 1990). In an ecocentric ethic the land and its needs are regarded as coincident with human needs. Both are sustained but neither is consistently dominant. The definitions and practice of sustainable agriculture demand a shift from an anthropocentric or egocentric ethic (the developing country with too little food being the exemplary case) to an ecocentric ethic. The former view, often called ethical egoism, is a normative theory about how one ought to behave. The theory says we have no moral duty except to do what is best for ourselves; the principle of self-interest rules (Rachels, 1986; see Chapter 4). It is the ethical equivalent of Adam Smith's "invisible economic hand." In this view, what is to be sustained is production of abundant food or fiber, and profit for the producer and for those who supply the resources (inputs) required to produce. The primary problem with this view is its failure to internalize the inevitable externalities (Merchant, 1990). Sustaining production is a good thing but it surely cannot always be the only or the highest value. When the technologies required to sustain production pollute water, harm non-target species, or contaminate food, it is hard to argue that production and profit should always be the highest goods. Thus, producers who are dependent on the land ought to ask if the missions of

agribusiness and environmental groups sustain or mitigate against the sustainability of the land, the producer's primary resource. The evidence from the mission statements studied does not answer the question. While it is obvious that brief mission statements can not include everything, it is equally obvious that what is omitted may be as important as what is included.

Lehman (1995) claims that a sustainable agricultural production system ought to be one that conserves resources, achieves relatively high energy outputs given its energy inputs, and provides sufficient, safe food for a community of people. Such a system might not yield income in excess of costs. That is, the system may not be profitable for the farmer. Evidence from the words used in mission statements (Table 9.2) shows that members of all three groups agree with Lehman concerning conservation, energy, food sufficiency, and food safety. Environmental groups use environmental words much more frequently than either of the other groups and therefore have objectives coincident with those of producers. The mission statements (Tables 9.3, 9.4, and 9.5) provide little evidence, but suggest that members of each group will strenuously object to the thought that any nation could endure an agriculture that was not profitable to producers. Profit is important to agribusiness and producers (Table 9.2) if they are to survive and meet the continuing demands for change. The evidence in Table 9.2 suggests it is not very important to environmental groups. People in agribusiness believe that agriculture is a business and must respond to the same profit demands and follow or be susceptible to the same economic and market rules that govern any other business.

In spite of the lack of a precise definition, and disagreement over the role and necessity of profit, sustainability is in vogue. It does not appear in the mission statements of many organizations within agribusiness, producer, or environmental groups (Tables 9.3, 9.4, and 9.5). Where it does not appear it is implied by the use of words such as environment, conserve, restore, preserve, and stewardship, but these words do not appear in all mission statements (Table 9.2). Sustainability is something that one might assume all groups support. It might be one of the things that all could agree is good. But in spite of its current popularity, it is not included in most of the mission statements presented herein.

Sustainability or its synonyms do not appear at all in the mission statements of producer and allied groups, and only once in those of agribusiness groups. The word or one of its synonyms (Table 9.2) appears most frequently (seven times) in the mission statements of environmental groups. The term environment is used nine times by environmental groups, but only three times by agribusiness and twice by producer and allied groups. I suggest, based on personal observations and comments from agricultural students and farmers, that producers are interested in sustaining their farms and farm life. It is not illogical to conclude that environmental groups are allies in the quest to sustain farms.

Mission statements may reveal a great deal about what an organization is about, and still not reveal everything. One must assume they reveal what their

creators want to reveal. It is tempting, but not acceptable, to read other meanings into such statements, to read between the lines or try to evaluate what is not included. Mission statements must be accepted for what they say. Coletti (1999) notes that codes of ethics come in glossy brochures, and environmental and social duties are featured in annual reports and presumably in mission statements. However, chief executives do not put such things at the top of their respective agendas. Environmental and social issues ranked only 13th among 16 marketplace challenges in a survey of 656 CEOs worldwide (Coletti, 1999). The top five issues were downward pressure on prices (mentioned by 48% of CEOs), changes in type or level of competition (43%), industry consolidation (41%), changing technology (25%), and increasing innovation (24%). Environmental, health, and safety issues were mentioned by only 46 (7%) of 656 CEOs. Perhaps, as mentioned earlier, what is omitted may be as important as what is said, and what is said may not be what is meant when the going gets tough. Agricultural producers ought to be aware of both the stated and, in so far as possible, the unstated goals of those who might be their partners in agriculture. Agribusinesses include words about their environmental and social responsibilities in their mission statements, but these do not assure they hold the values implied. One is compelled to wonder if these words are public relations ploys rather than an accurate reflection of corporate intent.

A test of Zimdahl and Speer's (1998) first hypothesis, that agricultural producers share missions and objectives with environmental groups and that their mission statements demonstrate their shared goals, is not a simple objective exercise. It is not obvious from the mission statements (Tables 9.3, 9.4, and 9.5) that these groups share missions or objectives. It is not obvious that they regard each other either as allies or as adversaries. Nor do the mission statements immediately reveal clear objective information on the second hypothesis, that agricultural producers do not share missions or operational objectives with agribusiness companies, and their mission statements demonstrate the lack of common interests.

Harwood (1988, p. 5) said: "In the early 1900s, popular thinking among farmers had led to the rejection of the portion of Jeffersonian thought that held individualism to be supreme." This led to establishment of farmer organizations such as the Farm Bureau and Grange. Farmers became convinced they could not stand independently of their neighbors, and their knowledge, equipment, and ideas needed to be shared if all were to succeed. Harwood (1988) cites Marcus (1985) to describe two sources of agricultural knowledge. Systematic agriculturalists looked to the developing agricultural support industries as their model and guide about how agriculture should be practiced. These industries included farm machinery as exemplified by the cotton gin, reaper, and steel moldboard plow. The fertilizer industry led the way to the chemicalization of agriculture, and although pesticides existed prior to World War II, their rapid development was a post-war phenomenon. Agribusiness was the source of numerous innovations and the technology for rapid increases in crop yield. Agricultural industry was widely

regarded within and outside farming as progressive and forward-looking. New products and new ways led to greater production and profit.

This view was opposed (and still is) by scientific (Harwood, 1988), or as I prefer, natural agriculturalists who look to nature as their model of how agriculture ought to be practiced. The central idea is that nature is the best teacher and its workings can be rationalized and formalized into proper agricultural practice. Farmers were regarded as natural historians whose knowledge of place and process would create good, environmentally benign agricultural systems. The twentieth century exponents of this view included Robert Rodale and Louis Bromfield, and more recently Wendell Berry, Wes Jackson, Miguel Altieri, and Francis Moore Lappé.

The view of the systematic agriculturalists is exemplified by the work of Avery (1995, 1997) and Waggoner (1994). In this view, human population growth is regarded as inevitable. There is general agreement among systematic and scientific agriculturalists that the UN median projection of 9 to 10 billion people by 2050 is reasonable. Those who will create the children are already here. The systematic agriculturalists assume that food demand will exceed supply. Avery (1997) concludes that by 2040 the world must once again achieve a tripling of yields on existing farmland. If that is not accomplished we will lose millions of square miles of presently wild lands and many now endangered species. Land that should not be farmed will be farmed. The fundamental claim is that one of two things must happen:

1. The same amount of land must become three times as productive, or
2. Three times as much land must be brought into production.

It is likely that neither will happen but they set the boundary conditions for the future. Avery (1997) claims that the "world has only one proven, effective strategy for protecting its wildlands and endangered species in the twenty-first century: getting higher yields of crops and livestock from the land we're already farming." Farmers, in this view, work at the hub of sparing land for nature (Waggoner, 1994). Farmers, enabled by modern technology, can raise more crops or animals per unit area of land. This, in Waggoner's (1994) view, helps keep food prices low and spares land for nature that would have to be used to produce food if yields are not raised. Avery (1997) suggests that crop protection technology and all of modern agriculture (Avery 1995) should be seen for what they are, "one of mankind's greatest environmental achievements, in the most conservation-minded era of human history." This view of agriculture is the view that agribusiness supports even though the evidence for this conclusion cannot be obtained from mission statements.

Those with the opposite view, what Harwood (1988) citing Marcus (1985) called the scientific view and I call the natural view, hold that systematic agriculture views only human beings as having inherent worth and the rest of nature is assigned instrumental value as a resource for humans; what Merchant (1990)

called the egocentric position. The evolution to modern, capital, energy, and chemically intensive agriculture was not done because of rational ecological analysis but rather because of scientific contributions that made it feasible, and low cost energy that made it possible, to use nature as an instrument to produce food (Altieri, 1985). Excessive dependence on the technology that characterizes systematic agriculture is not sustainable because of two inherent technological problems (Ausubel, 1996). The first problem is that technology's success is self-defeating. Technology makes the human niche elastic (Ausubel, 1996). We are able to overcome the limits of the natural world and impose our will upon it. Dominating and subduing are made easier by technology. But technology solves and creates problems at the same time. A good example is pest resistance to pesticides (including insects, weeds, and disease organisms). In the early days of pesticide development resistance was not a problem; now it is a huge problem that is dealt with, in part, by continuing to create and use more of the same technology that creates resistance. Resistance management is now part of pest management science. This is precisely the kind of problem solving that natural agriculturalists deplore.

The second problem with technology (Ausubel, 1996) is the "paucity of human wisdom." Technology creates the ability to kill and cure, to destroy and create, to do good or evil, to sustain or harm the earth. Few set out to do evil but few can see all the consequences of any technology. I do not argue, as some might suspect, that therefore we ought to stop science or control it more carefully. Scientific freedom is a great virtue. There is no question that the scientific advances that have led to modern agriculture have created more human pleasure than pain. The abundance of a modern grocery store is evidence of the pleasure agriculture has created. But when unbridled use of agricultural technology does not increase the well-being of all members of society and may in fact hurt some members, we ought to ask a new question about technological development. It is a moral question.

As agriculture changed rapidly after World War II, agricultural science focused on what could be done: We could replace the soil's fertility by adding fertilizer; design new, high-yielding plants; and selectively kill pests in crops with pesticides. Solving production problems always includes the question, Can we do it? But, more and more, we are faced with the moral question of what we ought to do: What should be done? This means that what was once just a technical question (Can we do X?) is now also a moral question (Ought we do X?). Moral questions are not addressed by any group's mission statement. As those engaged in agriculture begin to ask moral questions they may also ask:

1. What groups in our society seek answers to the same questions we have?
2. What groups think as we do?
3. With whom should we try to partner and form working relationships?
4. With what groups do we share common goals and methods?

Word frequency analysis of the mission statements of agribusiness, producer, and environmental groups (from Tables 9.3, 9.4, and 9.5) is shown in Table 9.2. The mission statements were read and the frequency of appearance of common words was recorded. These words were further divided into those that were human, environment, or business oriented. Words with human emphasis, such as health, safety, nutrition, society, quality of life, and community, were mentioned with nearly equal frequency by members of each of the three groups. Environmental groups used the terms public and society more often (eight times) than did agricultural producer and allied groups (three times); agribusinesses did not use these words at all. Environmental words such as environment, stewardship, and nature were not used often by either agribusiness groups (6 times) or agricultural producers (3 times), whereas environmental groups, not surprisingly, used such words 24 times. Agribusinesses frequently used terms such as profit, value, growth, and economic well-being (16 times). These words were mentioned only once by environmental groups. Agricultural producer and allied groups also emphasized the importance of economic success with seven uses of these words.

In each word grouping, some groups did not use the common words at all. In fact some mission statements are not particularly revealing of an organization's purpose or methods. It behooves members of any group to know the intent of others with whom they must work or may choose to form partnerships. As agricultural producer groups look for partners it will be unrealistic to expect all divisions will disappear as groups discover they have common interests. It has happened in other areas that groups that were at odds have found common ground and new alliances have been formed (Wilkinson, 1999). Environmentalists and loggers in Pacific Northwest timber towns have found that economy and ecology share more than the same prefix (Wilkinson, 1999). Their alliance has come about because of the marginalization of the labor and environmental movements by corporations. Agricultural producer and allied groups that value small farms and rural communities and the sustainability they imply may want to seek similar alliances. Analysis of mission statements is a place to begin to learn about those with whom one must work or one may choose to work. But it is only a beginning. Behavior and actions, as they always have, speak more loudly than words.

CONCLUSION

The Preface of this book says a primary goal is to continue the discussion of agricultural ethics begun by others. The task was to explore ethical positions in agriculture or the lack thereof using the metaphor of agriculture's horizon: the boundary line that separates and delineates one's outlook and knowledge. The book has praised agriculture's myriad accomplishments that have vastly increased food and fiber production and the efficiency of that production per acre and per

animal. It has, while acknowledging some opposing arguments, been unrelentingly critical of the fact that consideration of the ethics of agriculture has been lacking and that lack has limited agriculture's horizon and has created some of the public's negative view of agriculture—the essential human activity.

A related task (Chapter 3) was to demonstrate that underlying each set of views on important agricultural issues there is always an ethical position. I conclude that this is undeniably true. However, to demonstrate the correctness of the conclusion one must illustrate it with ethical positions held by those in agriculture and here the book fails. I, and others cited herein who have explored the ethics of agriculture more carefully, have concluded that agriculture has only one dominant ethic, which is not openly debated. It is accepted. It is the ethic mentioned above and best described by Thompson (1995): there is only one imperative—to produce as much as possible, regardless of the environmental/ecological costs and perhaps even if it is not profitable to the producer. Therefore, it is incorrect to argue that agriculture has no ethical standard at all. That is not true. The argument should be that the dominant ethical standard is unexamined and should not remain so. Agricultural science and technology have been major contributors to the liberation of most of those who reside in the world's developed countries from elemental want. Scientific advances and especially agriculture's achievements have been central to attaining a standard of living for many that was beyond human imagination in the mid 19th century (Sarewitz, 1996, p. 103). However, as Sarewitz (1996) points out, a parallel consequence has been "an unprecedented acceleration in the exploitation, modification, and despoliation of nature."

Those who practice agriculture cannot escape responsibility for its effects on nature but the dominant ethic ignores such effects. The effects are not a cost but a set of problems to be solved through more science and better technology. They are the price of bounty. Environmental effects are also evidence of human mastery over nature which has been subdued by science (Sarewitz, 1996). The highest priority for agricultural research is to continue to produce through domination of nature.

It is logical to conclude that agriculture's practitioners believe they have been extraordinarily successful and therefore deserve praise not criticism. Raising questions about agricultural practice and results is to miss the point. Agriculture is about results. What matters is whether or not people are fed. Ethical questions just get in the way. If one believes there is no objective truth in ethics, then it follows that a search for objective truth is futile. Objective ethical truth, given this view, is just a clever philosophical illusion.

Agriculture's practitioners including agricultural scientists clearly care about scientific truth. It exists and part of the task is to discover what is true. Lynch (2004), in a perceptive essay, points out that "caring about truth means that you have to be open to the possibility that your own beliefs are mistaken." It is mistaken beliefs about ethics that inform agriculture and need to be changed.

Debates about the ethics of agriculture are not trivial but essential to progress just as the search for scientific truth is. No scientist will hold to a scientific belief that is patently false. Similarly no one should hold fast to an ethical view or a view of ethics that is unexamined. There is objective truth in ethics and knowing the ethical foundation for action is just as essential as knowing the scientific hypotheses that support experimentation. Because agriculture is the essential human activity it is essential that it rest on a firm ethical foundation. Agriculture is not just about results—principles matter for they determine what truth's are sought.

TABLE 9.3 The published mission statements of agribusiness companies

Name	Mission Statement
AgrEvo	To continue to ensure that we conduct our operations in a safe and environmentally responsible manner and, through a process of sustainable, continuous improvement, will achieve and demonstrate continuing improvement across all aspects of Environmental, Health and Safety performance. 1. We want a healthy environment and food for all people. 2. All our efforts are focused on protecting Nature and increasing agricultural productivity. 3. To expand and thereby safeguard wildlife habitats. 4. To support agriculture in areas where it is climatically practicable and viable in the long-term. 5. We support high-yield, sustainable agriculture based on intelligent solutions in crop protection and environmental health, as well as green-gene technology. 6. We support preserving the environment and natural resources to maximum effect. 7. We help to optimize the usage of existing farmland and to protect Nature against further destruction.
American Cyanamid	To be the premier crop protection company in the industry. To achieve excellence in customer satisfaction through high performance products, superior service, and the highest ethical standards.
Archer Daniels Midland Company	To get food to the people who need it. Our mission is to feed the world. 1. By enhancing the farmer's bounty with our technological abilities in processing, transportation, and communication, we are part of a partnership that is uniquely equipped to meet this most important human need.
BASF	To be open to change and to seize it as an opportunity to focus on the most important issues and to make BASF quicker and faster in everything we do. Strategic Objectives—To increase BASF's corporate value by: 1. expanding our core activities, 2. strengthening cyclically robust operations, 3. increasing cost efficiency, and 4. focusing business expansion on growth regions.
Bayer	To steadily increase corporate value and generate a high value added for the benefit of our stockholders, our employees and the community in every country in which we operate.
Cargill	To raise living standards around the world by delivering increased value to producers and consumers. 1. By being the best at merchandising, processing and distributing agricultural and other commodities. 2. Reinvesting substantially all cash flow to provide needed products and services for customers, rewarding career opportunities for employees and attractive long term value for shareholders. 3. Be valued customer of suppliers and responsible neighbors in our communities.
Conagra	To increase stockholder's wealth. 1. To help feed people better. 2. To achieve premium results. 3. To serve our customers and meet consumer needs.

TABLE 9.3 *Continued*

Name	Mission Statement
ContiGroup Companies Inc.	Formerly Continental Grain Company. To build on significant growth opportunities in faster-growing high added value segments of our existing and other related businesses. To build an enterprise that produces maximum value for our shareholders, partners, customers, and people.
Dow Agro Sciences	To deliver innovative technology that exceeds market needs and improves the quality of life of the world's growing population. 1. Responsible pest control. 2. Aiding the production of an abundant, nutritious food supply. 3. To use plants as a renewable agricultural resource to produce new and improved agricultural outputs. Core Values: 1. Cumulative long-term profit growth is essential. 2. Excellence in performance is sought and rewarded. 3. Customers receive our strongest commitment to meet their needs with high quality products and superior service. 4. Products are based on innovative technology, continuous improvement, and added value for our customers and end users. 5. A deep concern for human safety and environmental stewardship, while embracing the highest standards of ethics and citizenship.
DuPont	Dedicated to improving life on our planet. 1. To answer the fundamental needs of the people we live with to ensure harmony, health and prosperity in the world. 2. To serve humanity with the power of all the sciences available to us. 3. To encourage unconventional ideas, be daring in our thinking and courageous in our actions. 4. To create superior profit for our shareholders and ourselves. 5. To respect nature and living things, work safely, and be gracious to one another and our partners.
Farmland Industries, Inc.	To be a global, consumer-driven, producer-owned "farm-to-table" cooperative system.
Monsanto	To find solutions to the growing global needs for food and health by sharing common forms of science and technology among agriculture, nutrition and health.
Mycogen	To be a fully integrated company involved in the invention, manufacturing and marketing of products to control pests and increase food production. Our products will be compatible with the environmental and social needs of a changing world.
Novartis	To improve health and well-being through innovative products and services. 1. To capture and hold a leadership position in all of our businesses with a strong, sustainable performance based on continuous innovation. 2. To meet the expectations of all our stakeholders—customers, our people, our shareholders and the communities in which we live and work.
Rhône Poulenc	To bring to the market through innovations in the life sciences and chemistry products and services intended to improve the well-being of mankind. 1. To improve the well-being of men and women in their natural environment.
United Agri Products, Inc.	To be positioned as a market leader with global influence, supplying efficacious, environmentally sound inputs to growers from seed to harvest, either direct or through retailers, resulting in annual growth earning of at least 14%.

TABLE 9.4 The published mission statements of agricultural producer and allied groups

Name	Mission Statement
Ag in the Classroom	A U.S. Department of Agriculture program designed to help students in grades pre K-16 become agriculturally literate and to integrate the critical role of agriculture in our economy and society into their teaching.
Agricultural Women's Leadership Network	To link women leaders of rural and agriculture-related interests to make a positive impact on our communities, nation, and world.
Agriculture Council of America	To initiate and serve as the coordination point for the distribution of factual information about modern food and fiber production, processing and marketing to a variety of audiences that will include the consuming public, general and trade media, policy makers, and consumer and other groups.
American Agri-Women	To build and strengthen alliances, communicate, inform, and cooperate with individuals and organizations to influence perceptions of agriculture.
American Egg Board	To allow egg producers to fund and carry out proactive programs to increase markets for eggs, egg products, and spent fowl products through research, education, and promotion.
American Soybean Council	To develop and implement policies to increase the profitability of its members and the entire soybean industry.
Animal Industry Foundation	To be the single, clear voice speaking out to the American public on behalf of livestock and poultry producers.
Colorado Corn Administrative Committee	To enhance our stakeholder's way of life and to provide vision and direction for current and future challenges by enhancing the value of corn, being good land stewards, and providing services and education to stakeholders.
Council for Agricultural Science and Technology (CAST)	To identify food and fiber, environmental, and other agricultural issues and to interpret related scientific research information for legislators, regulators, and the media for use in public policy decision making.
Dairy Management Inc.	To drive demand for dairy products.
Farm Bureau	To make the business of farming more profitable and the community a better place to live.
Henry A. Wallace Institute for Alternative Agriculture	To encourage and facilitate the adoption of low-cost, resource-conserving, environmentally sound, and economically viable farming systems. 1. To ensure that farm production gains not only are efficient and equitable but also maintain the soil, water, and air on which farming—and all human life—depend. 2. To provide leadership and policy research analysis necessary to influence national agricultural policy.
National Agricultural Center and Hall of Fame	To celebrate and communicate the heritage of the American the legacy of the leaders in agriculture.
National Cattlemen's Beef Association	To promote the common interests of the beef industry in the United States.

TABLE 9.4 *Continued*

Name	Mission Statement
National Corn Growers Association	To enhance corn profitability and usage in order to improve the quality of life in a changing world.
National Cotton Council	To ensure the ability of all segments of the U.S. cotton industry to compete effectively and profitably in the raw cotton, oilseed and value-added product markets at home and abroad.
National Council of Farmer Cooperatives	To protect the public policy environment in which farmer-owned cooperative businesses operate, promote their economic well-being, and provide leadership in cooperative education.
National Farmers Union	To protect and enhance the economic interests and quality of life of farmers and ranchers and rural communities.
National Future Farmers of America (FFA) Organization	To make a positive difference in the lives of young people by developing their potential for premier leadership, personal growth and career success through agricultural education.
National Grange	To improve the quality of life in America's communities. 1. To provide national representation for its members on agriculture and rural/urban issues. 2. To provide educational, community-based programs, projects, activities and leadership development. 3. To provide and/or assist in the creation of economic services.
National Pork Producers Council	To enhance opportunities for the success of the U.S. pork producers and other industry stakeholders by establishing the U.S. pork industry as a consistent and responsible supplier of high quality pork to the domestic and world market, making U.S. pork the consumer's meat of choice.
National Turkey Federation	To increase retail food service, international sales, consumer consumption, and awareness of the value of turkey products.

TABLE 9.5 The published mission statements of environmental groups

Name	Mission Statement
California Food Policy Advocates	To improve the health and well-being of low-income Californians by increasing their access to an adequate and nutritious diet.
Californians for Pesticide Reform	To expand the public's right to know about pesticide use and abuse, reduce that use and promote safer, more ecologically sound agricultural and urban pest management.
Campaign for Food Safety	To build a healthy, safe, and sustainable system of food production and consumption.
Center for Food Safety	To preserve organic food; ensure the testing and labeling of genetically engineered foods; and to carry out litigation efforts when the U.S. government fails to act appropriately. The Center is part of the International Center for Technology Assessment.

(*continues*)

TABLE 9.5 *Continued*

Name	Mission Statement
Center for Rural Affairs	To build communities that stand for social justice, economic opportunity, and environmental stewardship. To encourage people to accept both personal and social responsibility for creating such communities.
Center for Science in the Public Interest	To improve the safety and nutritional quality of our food supply and reduce the carnage caused by alcoholic beverages.
Consortium for Sustainable Agriculture Research and Education	To cooperatively advance a more just and sustainable agriculture and food system by: Enhancing our institutional and policy environment Cultivating our collaborative capacities Nurturing a supportive community We value the generation, synthesis, sharing and application of knowledge that is carried out under the following precepts: Farmers and public interest advocates acting as collaborators. Learning together from the heart as well as the head. Diversity. Innovative thinking and holistic approaches. Diverse approaches to solving problems and sharing knowledge. Experiential knowledge. Humility, Compassion, and Mindfulness.
Consumers Union	To test products, inform the public, and protect consumers.
Environmental Defense Fund	To find solutions to environmental problems.
Food Research and Action Center	To improve public policies to eradicate hunger and undernutrition in the United States.
Greenpeace International	To ensure the ability of the earth to nurture life in all its diversity. 1. To protect biodiversity in all its forms. 2. To prevent pollution and abuse of the earth's ocean, land, air and fresh water. 3. To end all nuclear threats. 4. To promote peace, global disarmament and non-violence.
Interfaith Center on Corporate Responsibility	To encourage corporations to accept responsibility for the environment, and conduct all aspects of their business as responsible steward of the environment by operating in a manner that protects the earth.
Izaak Walton League of America	To conserve, maintain, protect and/or restore the soils, air, wood, waters, wildlife of our country.
LOKA Institute	To make science and technology more responsive to social and environmental concerns by expanding opportunities for grassroots public-interest group, everyday citizen, and worker involvement in vital facets of science and technology decision making.
National Audubon Society	To conserve and restore natural ecosystems, focusing on birds and other wildlife for the benefit of humanity and the earth's biological diversity.
National Coalition	To focus public attention on the very serious pesticide poisoning

TABLE 9.5 *Continued*

Name	Mission Statement
Against the Misuse of Pesticides	problem and promote reduced pesticide exposure through alternative pest management strategies that use few or no toxic chemicals.
Natural Resources Defense Council	To safeguard the earth: its people, its plants and animals, and the natural systems on which all life depends: 1. To restore the integrity of the elements that sustain life. 2. To defend endangered natural places. 3. To establish sustainability and good stewardship of the earth as central ethical imperatives of human society. 4. To protect nature in ways that advance long-term welfare of present and future generations. 5. To foster the fundamental right of all people to have a voice in decisions that affect their environment.
Pesticide Action Network	To promote safer and more natural management of natural resources in place of reliance on chemical pesticides.
Organic Consumers Association	To make organic agriculture the dominant form of food and fiber production in the U.S. and around the world.
Resources For the Future	To conduct independent research—rooted primarily in economics and other social sciences—on environmental and natural resource issues. 1. It is impossible to make sensible policy decisions without balancing—if only in a qualitative way—the costs and benefits of proposed alternatives. 2. Once environmental goals are established, it is essential that we set about to accomplish these goals in the most inexpensive way possible.
Rural Advancement Foundation International	Dedicated to the conservation and sustainability improvement of agricultural biodiversity and to the socially responsible development of technologies useful to rural societies.
Sierra Club	To explore, enjoy and protect the wild places of the earth; to practice and promote the responsible use of the earth's ecosystems and resources; to educate and enlist humanity to protect and restore the quality of the natural and human environment; and to use all lawful means to carry out these objectives.
The Nature Conservancy	To preserve plants, animals and natural communities that represent the diversity of life on earth by protecting the lands and waters they need to survive.
Union of Concerned Scientists	To promote agricultural practices that minimize pesticide, fertilizer and energy use. To research and evaluate the risks and benefits of biotechnology in agriculture.
Worldwatch Institute	To raise public awareness of global environmental threats to the point where it will support effective policy responses. 1. To foster the evolution of an environmentally sustainable society—one in which human needs are met in ways that do not threaten the health of the natural environment or the prospects of future generations. 2. To conduct inter-disciplinary non-partisan research on emerging global environmental issues. 3. To provide information to bring about the changes needed to build an environmentally sustainable economy.

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